VOLUME 14 #4 JUNE 1999 PRICE $6

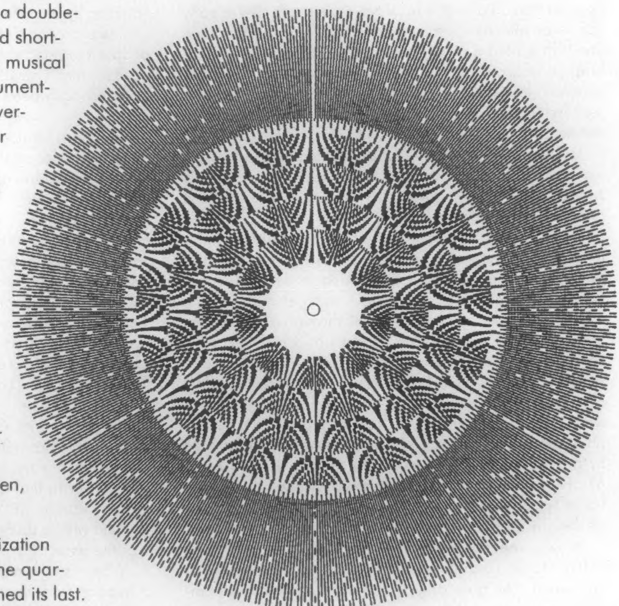
EXPERIMENTAL MUSICAL INSTRUMENTS

For the Design, Construction, and Enjoyment of Unusual Sound Sources

OVERFLOWING

Here in this, the 70th and final issue of *EMI*'s fourteen-year run, we have a double-issue's-worth of articles, letters and short-takes on diverse and imaginative musical instruments. Open it up and instrument-making ideas will spill from the over-stuffed pages with a clatter at your feet. Among them you'll find Barry Hall's globular horns, Brian Ransom's Dieties of Sound, Jacques Dudon's Photosonic Disk, Richard Cooke's Freenotes, soda straws from Robin Goodfellow, and various inventive indescribables from Ela Lamblin and John Berndt. There's also an essay from John Bertles on musical instruments in the classroom, and a complete how-to for circuit-bending from Reed Ghazala, and much more. So open, and read!

And remember: *EMI* as an organization is not going away, even though the quarterly journal will now have published its last. We'll continue to serve as a resource for people
interested in creative instrument making.



Above: Photosonic Disk by Jacques Dudon. See Jacques' article starting on page 36.

WITH BIG THANKS TO EVERYONE

Last words from EMI's editor

After fourteen glorious and crazy years, *Experimental Musical Instruments* now publishes its last issue as a quarterly journal. EMI as an organization will continue to operate in other ways, and I'll say more about that in a moment. But first, some corporate history.

I started publishing *Experimental Musical Instruments* as a bimonthly newsletter in 1985. I had enjoyed experimenting with offbeat musical instrument designs myself for — well, most of my life, it seems, though for the most part I hadn't done it very seriously. My knowledge of instrument making was pretty shaky, and my awareness of what others were doing in the field was essentially nil. I happened to hear on the radio — this must have been late '84 or early '85 — an interview with someone named Becky Blackley. She had started a newsletter for aficionados of the autoharp. It was called *The Autoharpoholic*, and under her excellent leadership it went on to have a good and successful run over many years. The thought was born in my head: maybe somebody could do something similar for creative, inventive, one-of-a-kind musical instrument explorations. Without knowing at first whether I was really serious about this enterprise (and having no illusions about attracting a large readership) I began to research the question of what, if anything, other people might be doing in the field of creative instrument making, and whether other magazines, journals or newsletters devoted to the subject happened to exist. Because I was getting to like the idea, I managed to convince myself through my investigations that there was room for what I had in mind. So it came to pass that in June of 1985 I sent out the premiere issue of *Experimental Musical Instruments* to a list of 40 charter subscribers that I had somehow drummed up. It was 16 pages long, with a few line drawings but no photographs. The choice of typefaces had been dictated by the availability of daisy wheels for the printer I was using. All of the articles in that first issue were written by me, but I didn't put bylines on them because it looked silly to have all the articles signed by the same person.

Now comes the part about how, following this debut, *EMI* got to be a big success. But, of course, that's not what happened. *EMI* grew only very slowly in readership numbers, and never achieved anything better than a rather wobbly, borderline sort of financial stability. Even now, after fourteen years, *EMI*'s subscriber numbers have remained microscopic by magazine industry standards. But it did turn out that there were people in the world who liked having a journal devoted to inventive instrument making. It wasn't a huge number of people, but the degree of support that *EMI* got from those people over the years was huge.

Soon we began putting out an annual cassette tape to let people hear the sounds of the instruments we were writing about. As time went on we pulled together and released a number of books and CDs. The issues of magazine itself grew quite a bit longer and a bit less home-made-looking. With time — I hope I'm not just flattering myself when I say this — something did seem to coalesce around *EMI*. The journal became a center for people interested in creative instrument explorations, and I believe that it gave a bit more definition to a field which had previously been scattered and diffuse.

And now, fourteen years later, having ridden the crest of the wave for all this time, I've decided to give myself and the magazine a rest. My reasons for winding down the magazine stem from a need for to make room for other things in my own life. I tell you that just as a way of emphasizing the following: The decision was most definitely not due to any diminishing of interest in experimental instruments among our readership around the world, or because the subject is in any way played out, or because there's any less to say about it now than there was in earlier days. As far as I can tell, the world of creative musical instrument design is as alive and exciting as ever — more than ever, in fact. Lots of good stuff is going on, and it can only continue.

(So, then, with the *EMI* quarterly journal no longer appearing, what will be the place to go for people who want to explore and keep up with new instrument making? The answer to that question has two parts: what *EMI* as an organization will continue doing, and what others in the field will be doing. Please look to the boxes on page 5 of this issue for the full story on these things.)

When I said a moment ago that *EMI* has received lots of support from the people it was made to serve, here's one of the main things I'm thinking of: After that first issue I was able to write fewer and fewer of the articles myself, as people who took an interest in the journal began to

submit articles for publication. EMI sometimes reimbursed those authors for expenses associated with their work, and we also did provide a meager sort of expense account to cover out-of-pocket costs for our regular contributors, but for all practical purposes, EMI's writers were not paid. Their contributions can be seen as gifts, proffered for the benefit of the magazine and its readership. Since the substance of the magazine really is nothing but the sum of all those articles, we can say that *EMI* has taken shape as a corpus of community input, freely given. So of all the thank yous I have to say, this is the biggest: *Muchas gracias* to all those who wrote for *EMI*, and as well to those who made the graphics and supplied the photos that made each issue a thing of value. I won't try to name all those people here. There are too many and I fear that I'd unintentionally miss some of the most deserving. But I encourage you, readers, to take a look at the bylines on the articles you've seen in *EMI* over the years, especially those that you've gotten the most out of, and say a thanks — say it right out loud, even if no one's in the room with you — to the people that made the articles.

I'd also like to publicly thank the people who've worked with me here in *EMI*'s office. For the last eight years or so, *EMI* has had someone coming in here, typically one day a week, to do the sort of organizational work that keeps things going, and to contribute in a thousand ways to editorial decision making, magazine aesthetics, general good taste, business know-how and so forth and so on. Currently that person, and a major factor in EMI's well being, is Karen Jaenke. Prior to Karen we've been fortunate to have Kim Johnson, Cathy Chaney, Janet Hopkin and Jeannie Filson. Also essential to EMI's operations have been Barlow Printing in Petaluma, California (they've printed every issue from the start!), Scott Hirsch of Securewebs (host to EMI's web site), Ace Printing and Mailing Service, the U.S. Post Office, Johnson & Hayward (overseas mail consolidators), and ... um ... probably others I can't think of just now.

So *Experimental Musical Instruments*, the quarterly journal, draws to a close. For me, the editor and publisher, it's been a wild ride; more fun than I can tell you, and also more work and worries and struggles than you'd want to know. I have had the privilege of meeting a truly fascinating cast of characters through this enterprise — a cross section of personalities the likes of which I can't imagine meeting anywhere else. Thanks and love to all.

— *Bart Hopkin*

IN THIS ISSUE

EXPERIMENTAL MUSICAL INSTRUMENTS

For the Design, Construction and Enjoyment of Unusual Musical Sound Sources

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Back issues, cassettes and related items available. Write for prices or see our ads in this issue.

WELL, LAST SATURDAY NIGHT, at two o'clock in the morning, I was walking around in Wal-Mart looking for an excuse to be creative. As a bluesman, I've always loved the sound of a rough, jangly metal-body dobro, but being able to afford one is a different story. Then I saw my salvation...in the hardware department. A beautiful — standard size — black gloss — MAILBOX! That was it!!! For four bucks, I could have my dream.

I took the thing home and proceeded to sacrifice a circa 1960s Kay acoustic guitar with a bolt-on neck. After planning out the bracing (I've had a lot of experience making and bracing cigar-box guitars — I've made over 180 of 'em), I got started on it. Within four hours, she was done. ...And it has that tone ... 80% musical tone ... 20% metal rasp!

The story doesn't end there. On Thursday, I had a chance to see and meet B.B. King. (I work for a radio station. It's a perk.) I figured I'd give him a cigar-box guitar and let him be one of the first to hear my new creation. I spent three days practicing his song "3 O'clock In the Morning" wanting to get it just right. Well, I went backstage and ... let's just say that the King of the Blues thinks I'm weird! He was either confused or just not amused whatsoever.

I was a little hurt at first, but I had him do something that made it up to me. I had him autograph my mailbox dobro ... right on the door. An urban legend has now been born ... I'm playing B.B. KING'S MAILBOX! Rumor now has it that B.B. isn't going to get any fan letters — or any mail for that matter for a long time!

— *Shane W. Speal*

HERE'S A PHOTO [right] of my first musical instrument. It's called the *Magic Marcophone*. It's not really all that experimental — it's a standard slide guitar, mounted on a piece of aluminum pipe with inlaid acrylic to indicate where the fretlines would be. I built it to try to capture a sound I heard in a dream I had — microtonal, and very metallic, but full and hollow, not tinny. I came pretty close to getting it.

— *Marc Berghaus*
Box 838 Meade, KS 67864; e-mail: pipe@midusa. net

EMI HAS BEEN A PART OF OUR LIVES for so many years that the last-ever issue is a sad occasion. The complete run of *EMI*, plus the cassettes, are the best resources we have in this field, and it is a tribute to the work of Bart Hopkin that he has continuously come up with new themes and subjects. Is there any possibility that the two recent CD-books from Ellipsis Arts (*Gravikords* ... and *Orbitones*...) might become something like an annual series? Since there is no obvious term that identifies the field of work that *EMI* has covered, even in this letter I find myself trying to use the term EMI ('ee-em-eye') for the whole field and not just the publication.

Pressure of other work in recent years prevented me from submitting two articles to *EMI*: on the coiled steel spring (a favourite sound source of mine) and on the instruments of my colleague Hans-Karsten Raecke; also a shorter article on Oskar Sala's Mixturtrautonium, to complement those published earlier on the theremin and Ondes Martenot. Neither was I able to respond to Bart's kind proposal to publish a written interview (or an article based on one) about my own work; I cannot think spontaneously like that.

For those who know my contributions to *The New Grove Dictionary of Musical Instruments*, it may be of interest that I'm now working on some 55 articles for the new edition of *The New Grove Dictionary of Music and Musicians*, scheduled for next year; these include my principal "Instrument Grove" entries, updated and often much reduced in length. But this is still likely to be the most substantial coverage of the field of EMI in a major music dictionary.

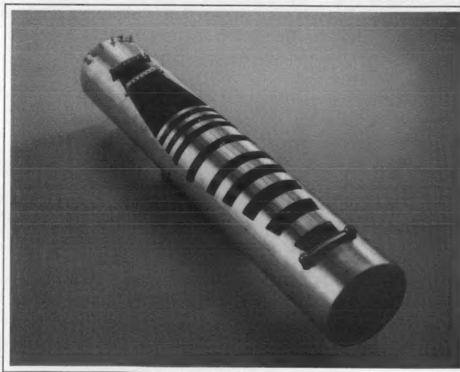
Finally a few thoughts about the penultimate issue (Volume 14 #3).

It would be impossible to exaggerate the significance in the field of EMI of what I call the *principle* of the nail violin (rods mounted at one end and free at the other), as mentioned in Emil Richards' letter. Hundred of recent instruments use it, like the Waterphone, most toy pianos, the Fender-Rhodes electric piano, most of the instruments of the Baschet brothers (not the glass "bowing" rods but the threaded steel rods to which they are bolted), most of Harry Bertoia's Sonambient sculptures, and instruments and sound sculptures by many others.

Regarding 'Speed Bump Music', my Singing Road project (1969), which has never been realized, is based not on transverse bands but on the singing sounds that were produced by car tires on certain motorway surfaces in the 1960s and 1970s. Two-voice chords or two-part counterpoint could be created by giving each half of a driving lane a different surface!

The unidentified double clarinet pictured in Robin Goodfellow's article is almost certainly a mijwiz, common from Turkey to Iraq; it has no gourd top, the player's mouth provides the wind

(continued on page 6)



Marc Berghaus' Magic Marcophone Photo by Doug Koch

WHAT'S NEXT FOR EMI

With this issue, the quarterly journal *Experimental Musical Instruments* appears for the last time. But as an ongoing organization, Experimental Musical Instruments will continue to operate as a resource center for all manner of things relating to creative musical instrument making. Here is a rundown of *some* of the things we have in mind for EMI's future, including some sureties and some maybes.

• Everything we've ever produced (well, *almost* everything) will continue to be available for purchase. This includes all of the *EMI* back issues (a great resource, very little of it being the sort of stuff that becomes outdated); all but the earliest of our cassettes, the world-famous EMI Wall Chart, and the various books and book/CD sets we've produced in conjunction with other publishers.

• EMI will continue with fresh output in books and CDs and the like, produced either in-house or, once again, in partnership with other publishers. What sorts of things? Well, there are many possibilities both big and small, some similar to our previous projects and some very different, but as many of them remain at this time in the realm of speculation, for now I'll say only "stay tuned."

• In addition, we are considering for the first time making available a range of items from outside sources. Up to now we have almost exclusively carried items that we've produced in-house or in conjunction with other publishers. We now hope to expand our catalog to include a broad, well chosen cross-section of the most valuable materials in the larger field of instrument making and creative instrument explorations. The focus, most likely, will be on on books, videos and CDs. We may also consider carrying other sorts of instrument-related items. If we can expand in this way, then EMI will have taken a step toward becoming the sort of all-purpose resource center that the world of creative instrument making has long needed.

• This hoped-for expansion depends on certain facets of rapidly evolving electronic-commerce infrastructure in the online world. We're just now looking into the ins and outs of it all. If we like what we see as we study the opportunities, it'll be a go; if not, this development may not prove feasible.

• We'll be expanding and improving the EMI web site. (Over the years, it must be acknowledged, the site has suffered from chronic neglect.)

In fact, with the magazine no longer serving as our ambassador, the EMI site will take on a more important role as a means of contact with the world at large. So please do check in now and then in the coming months at http://www.windworld.com/emi. At the same time, despite widespread talk about how the World Wide Web is the wave of the future, I would not want EMI to become another entirely web-based enterprise. So we'll be seeking to keep other lines of communication open. With that in mind, I hope our subscribers will forgive us if they receive a piece or two of unsolicited mail over the next few months as a way of letting them know what EMI is up to and what new things we have available.

SON-OF-EMI?

Some people have expressed an interest in creating a new publication, either online or in print, to carry on where EMI leaves off. At the time of this writing, plans have not taken shape, but you can check in at http://www.s-emi.org (think "son-of-emi") over the coming months to see how things are developing. If you think you might like to take an active part in helping to bring such a thing to life, contact James Coury at (360) 943-3984,
email James@artsonic.com.

OTHER EXISTING ONLINE RESOURCES

In addition to the ongoing EMI and a possible new s-EMI, there are a couple of online forums devoted to instruments and instrument making which will continue to serve as valuable points for information dissemination after the *EMI* quarterly journal has ceased publishing. They are:

• Musicians and Instrument Makers Forum
http://www.mimf.com.

MIMF is beautifully organized interactive web site. It features ongoing, open discussions on several fronts in the world of musical instruments, including one section devoted to experimental instruments. In addition to the discussion forums, the site has a variety of additional instrument-related features.

• The Oddmusic list,
with sign-on at http://www.onelist.com.

Oddmusic list is an informal email list devoted to interesting and unusual musical instruments of all sorts. Participants from around the world communicate ongoingly through open email exchange. Lots of knowledgeable participants; lots of interesting discussions; lots of information exchanged. Oddmusic has recently expanded to include a website (http://www.oddmusic.com), and list members and organizers are currently considering other organizational projects as well, including an Oddmusic CD compilation and an Oddmusic members convention.

chamber. The Indian snake-charming pipe (pungi) nearly always has one drone pipe without fingerholes, whereas on the mijwiz the twin pipes (one slightly detuned to produce raucous beats) are fingered in parallel.

Another method of blowing soda-straws: with several pairs of scissors a large group of children can try this out in a few minutes. Flatten and cut one end of a straw so that it resembles an arrow or inverted V (for children .'a snake's head'). Squash this slightly (like a double reed), soften it by sucking and then blow. This also has problems, too much saliva making the straw soggy, or the lips squash it too tightly; then one cuts the end off and starts again. Fingerholes could be made; but a great demonstration is to cut off successive short lengths while still blowing to produce a scale! [See Robin Goodfellow's article in this issue for more on soda-straw reed instruments such as this. — ed.]

Richard Waters mentions Darrell DeVore's combination bamboo bullroarer and guiro. In instrument-building workshops for children I always get them to add a guiro at the back of a different whirled instrument, which I call a 'bird warbler' (a miniature version made from tin is sold as a toy): a lengthwise slot is cut in a tube of undamaged bamboo closed at each end.

— *Hugh Davies*

GOODBYE EMI. *EMI* has been the most outstanding periodical I have ever seen.

Thank you for the fun, knowledge, stimulation, and cameraderie.

— *Dr. Guy Grant*
Tasmania

THIS IS JUST TO WRAP UP some loose ends.

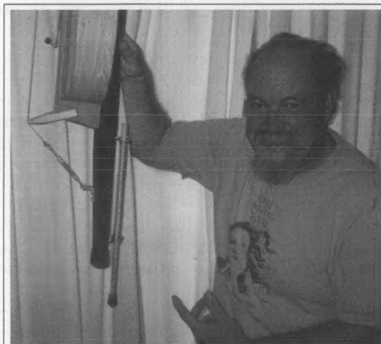
1) Recently while traveling through Shartlesville, PA (a recommended stop in PA Dutch country — while there eat at Haag's Hotel!) I stopped at a local yard sale. While looking at some junk and cutesy folk art stuff my eye was stopped by a funky bumbass in the corner. I asked the man if it was for sale and he said quite sternly "No." Then gave me a look and went right into the house. He soon came back out with two beat up leather suitcases filled with an outlandish collection of rhythm instruments and an old accordion around his neck. We proceeded to have a grand time on his porch and I got to play his bumbass, which he called a "Bumbaa", and had lots of fun with his stuff.

The reason I bring this up is that he had a neat attachment I hadn't seen before which I went home and made right away. Inspired by a series *EMI* ran on this subject [Volume 7 #3 and 4; Nov 91 and Jan 92] I had built the great Ulysses Bow of bumbasses - one that only the master could play, and even then only on a good day. I called it "Bob's a Bumbass." The missing element that finally brought it to life, which wasn't mentioned in your series, was this little attachment that turned the bumbass into a kind of rhythm pogo stick. (See photo.) It was just the power assist it needed and I thought others might appreciate it too.

2) In Reed Ghazala's deconstructivist work in slowing and randomizing synthetic speech and other synthetic sounds, and in the recent "God Box" articles [*EMI* Volume 14 #1, 2 and 3] about ultra low frequency sound, I was reminded of a deep personal experience I had many years ago. I was in a quiet receptive state in a gorge near the bottom of a waterfall. The overflowing stream was moving quickly and there were many rocks breaking up the flow and this produced a great complex of sounds echoing. Most of this was a cacophony in the white noise category, but I suddenly became aware of a very low "basso profundo" range, just at the edge of audibility. It sounded like strong slow broken syllables as on a recording played at a very slow speed. If you listened with the right frame of mind it spoke to you. It was the voices of many waters and in another time perhaps the voice of an oracle. Yes, the truth is out there.

3) I have been involved with double bridge harps (the Gravikord) for many years and have slowly learned of the many other exotic types of harps that exist. For several years I had been mulling over a design for a double cross bridge harp (four ranks of strings, two crossing). There are no double cross-strung harps that I know of, though its tunings have interesting possibilities. On most double harps (rare), the directly opposite strings are tuned the same, facilitating rapid diatonic play. On the Welch triple strung harp (rarer), the outside two ranks are tuned this way and spaced wider apart so that the central third accidental rank can be played. An interesting variation is the Chinese *Chung* or *Kung* harp (very rare) a double strung harp whose same tuned strings are co-joined to a lever so that one can be pushed while its opposite is played to achieve a glissando and accidentals. My dream double cross-strung bridge harp (nonexistant) would be tuned alternately as a kalimba with accidentals on the cross ranks. After making several drawings and spending much thought on it, I gave up before taking tool to material, deciding it was too complex for me. Imagine my feelings after reading the article "Occam's Razor" [*EMI* Vol 13 #3, March 1998] and seeing that the author independently came to the same conclusion after building an unsuccessful model of a similar double cross-strung harp! It's definitely a complex concept and not contained in my "less is more" esthetic - but then again look at the complexity of your average parlor piano. If anyone ever builds a successful one, I'd like to play it!

4) So - for all these things and more, kudos to *EMI* for these years of being such a unique and broadly open vehicle of the human imagination. Somehow in the guise of a music magazine the grounds of the spirit you really cover is far broader. Thanks for the many other delightful surprises too numerous to mention which touched me in special places that I thought were very private and unique, and thereby letting me know that there is a



Bob Grawi points out the pogo stick feature that helps to bring his bumbass to life.

community of similarly sensitive souls scattered about out there somewhere. Unfortunately there is nothing I know of that can take EMI's place. So - so long for now, and thanks for the long and beautiful run.

Bob "Gravikord" Grawi

NOTES FROM HERE AND THERE

REMEMBER! This is the final publication of *Experimental Musical Instruments* as a quarterly journal, but EMI as an organization is not going away. EMI will continue in many different ways to support creative work in musical instrument making. We'll try to stay in touch however we can, but the easiest way to keep up with EMI in the future will be to periodically check our website at http://www.windworld.com/emi.

EMI's VOLUME 14 CASSETTE WILL BE AVAILABLE SOON YOU CAN ORDER IT NOW!

The latest and lastest in *EMI*'s annual cassette compilation series will become available around the first of August. The cassette, titled *From the Pages of EMI Volume 14*, presents the sounds of instruments featured in *EMI* during this last year — that's the four issues dated September 1998 through June 1999. A wonderful mix of instruments will appear, including Richard Cooke's Freenotes, Dwin Craig's Dwinstruments, John Bernt's uniquenesses, Reed Maxon's giant steel tanks, Paul Panhuysen's architectural long strings, Jim Schmidt's logically fingered saxophones, John Bertles' Bash the Trash instruments, Richard Waters' bamboo instruments, Andy Cohen's dolceola, Jacques Dudon's photosonic disk, and several more not yet confirmed at the time of this writing. This final edition in our cassette series is a particularly good value because, while we've held to our longstanding low price of $8, the last year of the magazine has featured a larger-than-ever number of articles and instruments, and as a result the volume 14 cassette will be really crammed with music.

See the ad near the end of this issue's Notices section for details on ordering the new cassette. You can order any time now; we'll send the new tape around the start of August.

EMI BACK ISSUES

You won't be seeing any new issues of this quarterly journal after this one, *BUT*! all of *EMI*'s earlier issues remain available. Very little of the content of those issues is the sort of stuff that becomes outdated; the ideas and information are as valuable now as they were when they first appeared. The back issues of our first twelve years are available in paper-bound, photocopied one-year sets, while those from the latest two years can still be had in the original press run. For details see our ads toward the end of the Notices column or elsewhere in this issue.

A NEW BOOK AND CD OF GOURD INSTRUMENTS

Making Gourd Musical Instruments, by Ginger Summit and Jim Widess, will have just been released by the time you read this. In preparation for this book, the authors — long-time gourders themselves, with excellent earlier books already to their credit on gourd growing and gourd craft — researched gourd instruments from around the world, gathering instruments, photos and information from makers near and far. They then set about producing for themselves dozens of the most practical, effective and home-buildable gourd instrument types they found. These are described in the book, with step-by-step construction photographs and descriptions. Most of the instrument are simple to make, requiring a minimum of special tools or materials aside from the gourds themselves. Photographs of and background information on many more beautiful gourd instruments from diverse builders and cultures further enrich the book. To accompany the book, but sold separately, the authors are producing a CD featuring thirty of the instruments described the book.

Making Gourd Musical Instruments is published by Sterling Publishing. You can look for it in bookstores or libraries, or, better, order it direct from the authors at The Caning Shop, 926 Gilman St., Berkeley, CA 94710, phone 1-800-544-3373, email caning@caning.com, or visit http://www.caning.com.

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For information on subscriptions, books, and other items we have available, see our ads near the end of the Notices section and elsewhere in this issue, or contact us.

THE ODDMUSIC MAILING LIST (an Internet forum for people interested in unusual musical instruments of all sorts) has recently put up a web site devoted to the Oddmusic list, its people and activities, and all things relating to odd instruments. At the time of this writing the site, in the hands of John Pascuzzi, is just being built, but even at this early stage it's well organized, attractive and inviting. You can visit at http://www.oddmusic.com.

SOUND SYMPOSIUM 2000: The Sound Symposium festival, the highly praised bi-annual celebration of sound arts taking place in St. John's, Newfoundland, will have its next flowering in the summer of the year 2000. In this coming celebration, the festival's organizer Don Wherry reports, there witll be a strong experimental musical instruments theme. For information and updates, write 81 Circular Rd., St. John's, Newfoundland, Canada A1C, 2Z6.

ANNOUNCING the release of the first improvisational, artistic, multi-media CD-ROM "Millennium Mind Capsule." This CD-

ROM contains virtual, playable experimental musical instruments as detailed in the June 1999 edition of *Experimental Musical Instruments* (see "Call for Submissions"). Conduct or be a player in a virtual orchestra or walk through an online art gallery. Play Surrealist games where you test your poetical and irrational skills. Enjoy the music, poetry, and visual art of Jess Walker, LaDonna Smith, Wally Shoup, Dorah Rosen, Greg Roberts, Dave Knott, Craig Hultgren, Ginger Hood, Jan Hathaway, Glenn Engstrand, Joee Conroy, Keith Collins, Wyman Brantley, John Burns, Leah Alford, and Gregory Acker. Both Mac and PC computers can play this CD-ROM. Minimum requirements are a multi-media computer with CD-ROM drive and modern web browser. Send $10 (U.S.D) in check or money order payable to Glenn Engstrand at 100 First Street, Suite 100 Box 162, San Francisco, CA 94105, U.S.A. For more information, email Glenn at touchles@sirius.com

Calling all instrument makers and sound sculptors: Here are two calls for submission for upcoming sound-art and sculptural musical instrument projects:

BUMBERSHOOT 2000, The Seattle Arts Festival, has written to say that they are seeking participants for a fine art exhibition of kinetic musical instruments featuring works by renowned kinetic artist, Trimpin. "If you are the owner or builder of an artrageous acoustic, kinetic instrument please contact us!!!! Send your contact information, short description and photograph or slide (materials will be returned but please do not send originals) to: Bumbershoot Visual Arts, PO Box 9750, Seattle, WA, 98109-0750. Bumbershoot is held each Labor Day Weekend on the spacious Seattle Center grounds and features over 2000 regional, national and international artists of all disciplines in over 15 indoor and outdoor venues. For more information, contact Dani Bennett at One Reel: (206) 281-7788 x.239/danib@onereel.org. We appreciate all information and input!"

And, from Peter Struble —

THE SOUNDSCAPE DESIGN INVITATIONAL 2000 (SDI-2000): If you are reading this, you are invited to participate in the SoundScape Design Invitational-2000.

Access to music education and the instruments for making music is a right that everyone should enjoy. This project seeks to further accessibility to musical experience and provide the joy of making music to the greater community.

Entrants for this invitational are asked to submit designs for individual or multiple panels which produce musical sound in a specific scale tuning and demonstrate acoustic principles relating but not limited to, fundamental understanding, resonation, wave movement, and vibrational transfer. Panels modules will be designed to fit within a panel frame of fixed dimensions.

This project will be posted on the World Wide Web May 1, 1999. Entries are being accepted May 15 - December 31, 1999, with finalists to be notified in March 2000 and construction at the site in Austin, Texas to follow that. For further information contact strublep@austintx.net RE: SDI-2000

Communicating with René: *EMI*'s correspondent in the Netherlands René van Peer does not want to see any communications waylaid following a recent email address change. His new email is r.vanpeer@wxs.nl.

In the "Resources" listing at the end of Richard Waters' article "Bamboo and Music, Part 2" in *EMI*'s last issue, we neglected to include bamboo wind instrument maker Ángel Sampedro del Río among the several leading bamboo instrument makers listed. Angel can be reached at bambu@arnet.com.ar, or visit http://www.usuarios.arnet.com.ar/bambu/.

CORRECTIONS

Because *EMI* inevitably sometimes make mistakes, we occasionally have to print a correction for an error that appeared in a previous issue. But what about errors appearing in this final issue?! With the mad rush attendant on getting out this oversized closer, there are sure to be a few errors here. For mistakes or inaccuracies in this issue, apologies in advance. If any particularly egregious ones appear, we'll correct them on the *EMI* web site. And for the blunders we've occasionally perpetrated in the past, your patience and tolerance have been much appreciated.

April Latragna has sent this report on the recent *Sinsoidal* sound-art exhibit in San Francisco:

SINE WAVES AND THE MUSICAL ARTIST

The Art Gallery in the Cesar Chavez Student Center at San Francisco State University showcased *Sinusoidal*, a sound exhibition in mid March and April that expanded the definitions of music and sound, sculpture and instruments, new and old technologies, art that reflects nature, and sounds of human existence. The exhibition, curated by sound artist Ed Osborn and myself, composer/curator April Latragna, included sonic sculptures, pirate radio interactive objects, telephone art by Ian Pollock and Janet Silk (in a work called Phantom Line that can be accessed at anytime by calling 415.522.0605), and experimental musical instruments featured in Bart Hopkin's book and CD, *Gravikords, Whirlies & Pyrophones*. Visitors to the gallery could listen, touch and interact with much of the work.

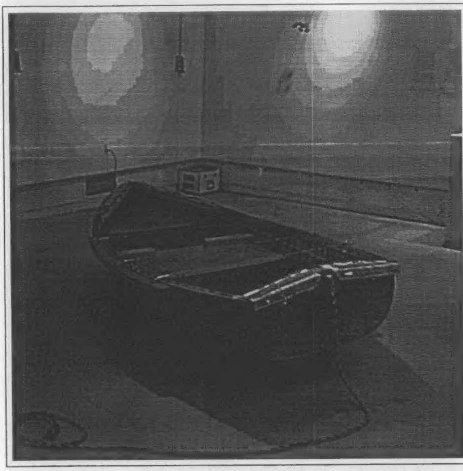
The common theme running through the works in the exhibition was their atonal and beautiful emission of sounds (hence the term *sinusoidal*), but they expressed a variety of different types of techniques, uses and concepts. The ear-tingling exhibition expanded the definitions of music and noise with artists such as Qubais Reed Ghazala, whose experimental musical instrument, the Trigon Incantor, was noisy and chaotic yet, as professor CeCe Landoli put it, "a gas". The engineer, musician and instrument builder Oliver DiCicco defied the definition of fine art with his utilitarian musical sculptures. Other installations worked as robotic noise makers, such as Oliver's piece titled *Web Site Insects* and the Gamelan tinkering of Shawn Decker's *Divided Circle*.

Like most improvisational composers who turn to making instruments, these artists do so because they find the academic practice of music too limiting and strive for their own personal sound. Visual artists work with the exploration of sound and sound sculpture because it is moving and emotional to vibrate into space and the body of the gallery visitor. There was a playfulness in works such as Brenda Hutchinson's *Giant Music Box*, Bill and Bary Buchen's playground instruments, and Judith Blankman's rock-filled teetertotter.

Some pieces in *Sinusoidal,* such as those of Richard Lerman and Phil Dadson, tried to move the visitors to remember nature in light of technology. Richard Lerman captures natural sounds of birds with naturally constructed speakers made of one strand of hay removed from the Arizona Sonoran Desert playing the recorded sounds of birds native to the area. New Zealand-based Phil Dadson confronts nuclear testing with his experimental instruments. Another political and social activist is Jesse Drew, who strives for democracy over the airwaves. His piece broadcast the Sinusoidal show through a pirate radio station.

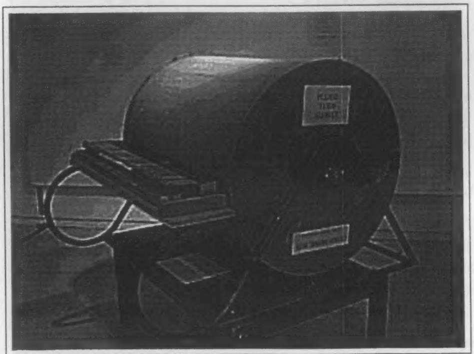
Overall the exhibition was a vibrating and beautiful experience.

April Latragna is the co-curator of Sinusoidal, manager of the Art Gallery in the Cesar Chavez Student Center and IAC graduate candidate at San Francisco State University.



From the Sinusoidal exhibit at San Francisco State University

Above: Judith Blankman and Marlyn Hudson's collaborative Dingy instrument, strung with music wire. Below: Brenda Hutchinson's Giant Music Box.



SONIC TOOLS

In August of 1998, music therapy student David Knott ran a program among homeless youth called Sonic Tools, devoted to making and playing musical instruments from found materials. It took the form of five three-hour afternoon workshops at the Orion Center, a drop-in center in Seattle which provides hot meals, medical services, and a variety of educational, recreational and social services. The idea behind the program, in David's words, was

... to use experimental instrument building and free improvisation

WEB SITES OF INTEREST

Here's this issue's listing of web sites relating to unusual musical instruments. Many more are listed in previous issues of *EMI* and on the links page of our own web site at http://www.windworld.com/emi. In addition, please take a look at Glenn Engstrand's "Site Check," next page.

Anne Bell's Clarinet Website Index (plus a variety of other specialized musical topics on this well organized links page): http://www.sneezy.org/anne_bell/

Papers presented at the Acoustical Society of America's 136th Meeting, including more on the extraordinary sound reflection effects in a Mayan temple: http://www.acoustics.org/136th/lay_lang.html

Lots of flute acoustics and some violin acoustics — a set of interlinked sites from the Musical Acoustics Group at the School of Physics, University of New South Wales: http://www.phys.unsw.edu.au/~jw

New address for Robert Froehner's musical saw and theremin page: http://www.fastlane.net/~sawman

Newly established web page for the Oddmusic mailing list devoted to unusual musical instruments: http://www.oddmusic.com

Instruments, non-standard musical scales and just intonation software from Buzz Kimball: http://members.xoom.com/novosonic

Didier Ferment's aeolian organ, with links to pages on other fascinating projects form this French maker of kites and more: http://www.neuronnexion.fr/~dferment/son_eole.htm

Uli Wahl's sound kites: http://members.aol.com/woinem1/index/index.htm

Will Menter's music and instruments (llechiphones and more): http://www.perso.wanadoo.fr/willmenter/

How-to for Shona mbira making from a leading Zimbabwean maker, in an article by Paul Berliner: http://www.bham.net/soe/stm/jkindex.html

Spirit Talk Mbira group: http://www.bham.net/soe/stm/

Bradford Reed's pencillina: http://home.earthlink.net/~braf/

Charlie Blacklock's "Internet Headquarters for Saw Players": http://www.mtco.com/~wentwrth/musicsaw/musicsaw.html

Downloadable programs to turn your computer into a hands-on musical instrument, including a mouse-controlled "theremin", an imitation nature sounds generator, and more: http://www.sagebrush.com

Matt Heckert's automated sound machines: http://www.mattheckert.com/

Panpipe manufacturer: http://www.dajoeri.com

as a means for increasing self-expression and self-esteem in young people. By creating sonically interesting artifacts from castaway and found materials, the participants realize their individual creativity, developing a bond with a positive and healthy part of their deeper selves — their musical selves. While the project is anything but a cure-all, and some of the kids have a greater appreciation for inventing their own music and instruments than others, it does present an opportunity for experimentation and growth in a hands-on process.

David had materials for several instrument types on hand, among them: walnut shell rattles, consisting of many shells drilled, strung on a rubber band, and looped to form a bracelet; stringboards, which are board zithers serving as platforms for creative exploration of string preparations and manipulations; pan-lid gamelan; lid-knob bird calls; ballyphones, which are membrane-reed wind instruments of the sort described in *EMI* Vol. 7 #3; and flappy drums, which are tin-can drums with attached string beaters.

By design, David ran the program loosely and informally, providing the participants with opportunities for instrument explorations in a manner free of coercion. A look at the journal David kept as the workshop progressed reveals that some of the kids responded with disinterest or cynicism as others came around and took part more willingly, while a special few really seemed to enjoy and gain something from the process of making something on their own, exploring its potentials, and presenting it to

SITE CHECK

Here we are, the last article on Internet resources for experimental musical instrument inventors. The previous article instructed you how to find EMI related materials on the web. This article visits those fun sites that feature the more theoretical side of experimental instruments. Actually, most of these sites are about alternative tunings, electronic instuments, and religio-psycho-acoustic effects of music.

http://www.exploratorium.edu/exhibits/highest_note/ex.about.fr.html
This dynamic presentation digitally recreates three auditory illusions found at the Exploratorium Science Museum in San Francisco, California; the Sheperd Scale, the Tritone Paradox, and the Risset Scale.

http://ccrma-www.stanford.edu/CCRMA/Overview/Overview.html
This is the home page for the Center for Computer Research in Music and Acoustics Department of Music, Stanford University. Electronic instrument inventors will want to click on the Research Activities link.

http://www.ccsr.uiuc.edu/People/gmk/Papers/ChuaSndRef.html
Those interested in building electronic instruments based on chaos math should come here.

http://www.beacham.com/digital_stradivarius_217.html
A nice theoretical discourse that brings into question whether or not we should even try to make electronic instruments sound like acoustic ones.

ftp://ella.mills.edu/ccm/tuning/
Those interested in diving into the wild and wacky world of CSound should come here. CSound is a sound synthesis software system that runs on many platforms. It's very good for building alternative sound patches and tuning systems. For the FAQ on CSound, check out http://music.dartmouth.edu/~dupras/wCsound/Csound.faq.1.02.html

http://corporeal.com/welcome.html
A great site devoted to Harry Parch.

http://www.cco.caltech.edu/~vidya/music/srutis.html
Indian intonation systems are not arrived at in a slapdash way. Theirs is a rigorous and highly theoretical approach. This page gives a good introduction to a subject that you could spend the rest of your life studying.

http://www.ixpres.com/interval/monzo/homepage.html
Microtonal music theory a.k.a. Joe Monzo.

http://uq.net.au/~zzdkeena/Music/KeenanTuning.htm
David Keenan invented his own tuning system which you can learn all about here.

http://www.ilhawaii.net/~lucy/index.html
This intonation system is based on a mathematical abstraction called Pi (which is the ratio of the circumferance of any Euclidian circle to its diameter). Originally invented by John Harrison and rediscovered by Charles Lucy. This web site will tell you everything you want to know about it. The site also includes samples and other resources.

http://www.users.globalnet.co.uk/~bunce/
Introduction to electronic music theory.

http://members.aol.com/bpsite/pythagorean.html
A tutorial on Pythagorean scale derivation.

http://www-ks.rus.uni-stuttgart.de/people/schulz/fmusic/recursion.html
Nicholas Mucherino proposes that the future of music is recursive.

http://www.pacificnet.net/~nowitzky/justint/dom7.htm
This site promotes the joys of the dominant seventh chord.

http://www-ks.rus.uni-stuttgart.de/people/schulz/fmusic/
Normally, I find fractal music to be boring but this site with its excellent samples is an exception.

http://www.dnai.com/~jinetwk/
The home page for the Just Intonation Network. Join the revolution now!

http://cmp-rs.music.uiuc.edu/
This is the home page for a very savvy group of electronic experimental music inventors and composers. Those interested in techno-toys should click the Computer Music Project link.

http://www.spyral.net/newband/zoomprimer.htm
Dean Drummond discusses his zoomoozophone: a 31-tones-per-octave, just-intoned metalophone. He studied with Parch and uses tonality diamonds to describe this instrument.

Well, there you have it. Though this fine organ for experimental musical instruments has dutifully served its purpose and is going into retirement, I must conclude from my searches on the web that interest in our field is greater now than ever. See you out there.

others ... really not a bad record at all, for a group of kids with enough reasons of their own to be disaffected and distrusting of adults.

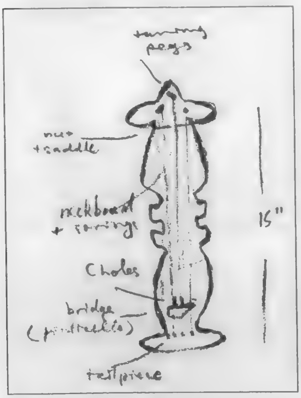
Composer and trombonist Stuart Dempster served as the mentor and observer for the project. The project was made possible by a Julie Carson Undergraduate Research Grant from Willamette University. David Knott will graduate from Willamette this year and head back to Seattle to establish a private music therapy practice. David's CD *natura naturans*, to be released this summer on Anomalous Records, is a recording of one of his larger stringboard installations played live. David can be reached at PO Box 95595, Seattle WA 98145, or by email at dknott@willamette.edu or bg269@scn.org.

Andrew Stylianos writes of instrument explorations at his studio in New England:

MUSIC MADE — END OF CENTURY

East of Vermont and New Hampshire hills, through seasons of sun or rain and snow, an assortment of instruments were retrieved or made in my original studio. Wind instruments were collected out of mostly synthetic blueprints, materials recently found suitable for chamber players of recorders, ocarinas and bird whistles. String instruments were the regular violins and guitars and lut-guitars, those tuned like the guitar but in a historical shape from Europe. A piano or toy-size piano or two, mechanical kalimbas sat next to percussion forms both old and new, and medieval rotating church or salesman rattle in off-white wood and Neapolitan shaking whips, with a Mexican witch-doctor rattle that they used for ceremonies, gave all sorts of sounds and impressions.

By chance I found softwood scrolls that are a must for violin-making. Together glued side by side with regular epoxy, they made an alluring female shape: bodies — arms and breasts and legs (see detail from my shop). I then got to work caulking the middle, and of course the peg holes on the top. Down the vertical middle where it was glued and caulked you could run the fingerboard and strings — to a bridge standing in front of a tailpiece of screws and adjusters for fine tuning. You might ask why the well-known female shape? See Heron-Allen's book on violin-making, chapter five on vagaries and diverse shapes and materials for the violin. They were to resemble the most domestic or quotidian life — a soup laddle — coat-hanger — or the most strange — glass violins—leather violins and more.



— Andrew Stylianos

ALBERTO MAGNIN of Argentina has been working in gourd, leather, horn, bamboo and other natural materials to create instruments that are based on traditional designs from around the world, and at the same time uniquely his own. He recently sent these photos and notes on his work.

THE KALIMBA OF LEATHER

The first kalimba I saw in my life was when I was 13 or 14 years old. My parents came back from a trip to South Africa and brought me a gift: a little gourd with some hammered wires over a thick piece of soft wood. It was surely an instrument made rapidly for the tourists, but its sound kept the essence of the kalimba, and shortly I discovered that moving the wires up or down it changed the tuning.

At that time all I played was percussion on the table and the back of the bed, and the kalimba remained looking at me from its place on the wall.

Years later an Argentine luthier, Oscar Trezzini, produced a model of a wooden kalimba with screws and a crystalline sound which he sold in the handcraft market of Buenos Aires. I saw them when he appeared at El Bolson, the little town near where I live in the mountains in the south of Argentina.

I remembered my little kalimba hanging in my parents' house and the magic began to work. In two days I constructed my first instrument: a trapezoidal box of caoba wood and bridges of metal and wood that I still keep.

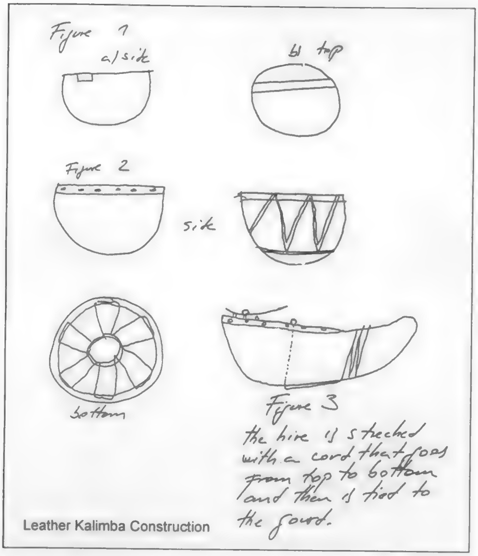
For more than twelve years I have experimented with many different materials: gourds, bamboo, coconuts, carved wood, horn, ceramic, glass, nuts, etc; making minikalimbas and maxikalimbas, and double kalimbas for playing looking at someone. Recently I saw the possibility of putting leather on top of the instrument instead of wood. When I finished my first kalimba of leather I wondered why I had never before heard or seen a kalimba made with this material. Their sound is so loud and long, having also some percussive sensation; it gives a new dimension to this mystical object.

Perhaps the reason that leather-topped kalimbas have not been made before is because the instrument, traditionally made in wood and serving such an important role in rituals and tribal medicine, has to conserve certain rules in its construction, and so innovation has been avoided. Or perhaps such innovations do exist, and it's just that I have never had the opportunity to see them.

Because of that I wanted to tell you how to build a leather kalimba.

We cut a thick-walled gourd and we place across it a piece

Leather Kalimbas by Alberto Magnin



Leather Kalimba Construction

of wood of 2x3 cm., making an adaptation in the gourd as seen in figure 1. Then we attach a hide over the open part. We can glue it or hammer it or tie it with leather or rope. The wooden crosspiece will be used for screwing the upper bridge with Parker screws. When we have the hide in its place we put the other bridges over the wood. If we prefer, we can put the front bridge farther forward on the hide where the wooden cross piece is not beneath. In that case it is better that the sides of the bridge reach the edge of the gourd, because if not the hide deforms greatly.

The hide, being much thinner than a piece of wood, has more vibration and it blows air that will move your hair.

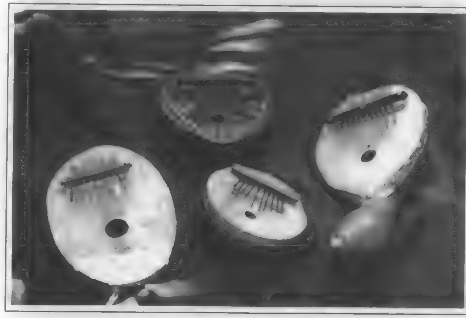
The leather kalimba makes construction simpler, since the top doesn't require sanding or lacquering.

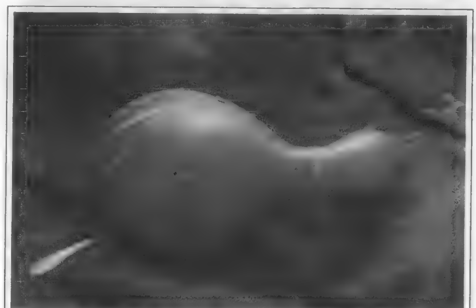
If the gourd is big and the hide is well tightened, then the instrument is also a little drum. Today I was experimenting with putting another hide in the bottom part of the gourd. That increases the vibration of the instrument and gives us another drumhead.

Also we can stretch the hide when it is loose by tying a cord from the center of the hide to the opposite part of the gourd passing through the middle of the resonator as in the drawing.

We must remember that many instruments in antiquity had hides on top, such as the tortoise-shell lyra of the Greeks, the garaia (the gourd and leather guitar of Gambia), the Armenian violin, the kemanja, the kora and many others.

Another instrument that I combined with leather is the Wupak, whose name comes from the sound of the instrument: Woo! Pak!. It is a big, thick-walled gourd (here I found them in Uruguay) in which I make two holes, one in its neck and the other in the middle part of it just like in an udu drum. Then I open a bigger hole over





Photos this page: Instruments by Alberto Magnin.

From top to bottom: Wupak, bamboo xylophone, leather kalimbas, and leather kalimba, rear view showing the optional cord, which controls the hide tension.

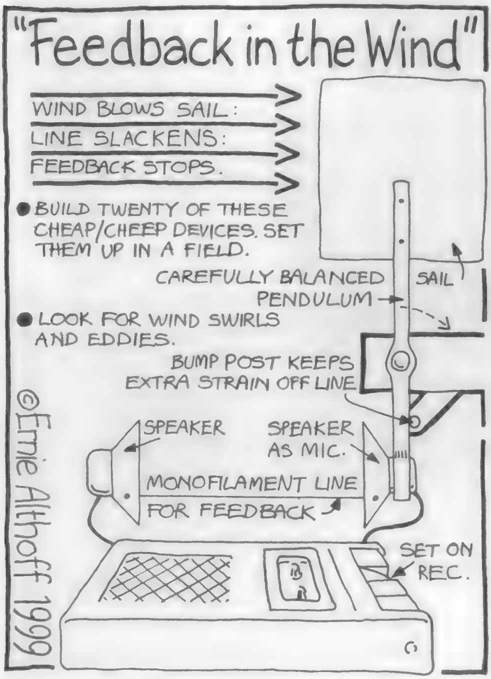
which I put a hide. You can change the tone of the drum by closing or opening the hole in the side of the gourd. It's very easy to make; the only secret for a high quality sound is in the perfect cleaning and lacquering of the inside of the gourd. Sometimes I first burn it.

Another innovation or mix of instrument is a bamboo xylophone with horizontal bamboo resonator. This instrument also incorporates the system of amplification and distortion of the sound used in the Timbila xylophones from Mozambique. Here's how this system works: After making the keys and the tuned resonators, we make a hole of about 1 to 1½ cm. at the end of the bamboo resonators that we have closed with a thin piece of wood. Then we glue a piece of cellophane paper over the hole. When you hit the key with a soft mallet, there is a gain of about 30% in volume and more richness in harmonics.

For over twenty years I have been dedicated to the investigation of instruments of the world. I began with American wind instruments from the quechuas to the mapuches. I was always interested in combining natural materials — for example, making ocarinas of wood and horn. Now I am making djembes and kalangus of gourd and bamboo, and toba violins (an Indian instrument from the north of Argentina) of gourd and wood.

All of these instruments are made for sale. I have some in stock and others can be available a few days after you order them. For more information you can reach me, Alberto Magnin, at Campana 3251 dpto.8, Capital Federal, Argentina; Phone: 5048203.

— Alberto Magnin



IN EMI's JUNE, 1998 ISSUE (Volume 13 #4), we printed photographs of several instruments from San Francisco sound sculptor James Harbison. Now, to bring us up to date, here is a picture and some notes from James concerning his most recent project.

These slides that I am sending are of my Dumpstick, a monster rainstick/rattle that measured ten feet by two and a half feet in circumference. It was made of recycled materials (oil drums, steel rod and steel bits) in a space made available to artists by the Sanitary Fill Company, the company that runs the San Francisco dump or *rather the San Francisco Recycling and Transfer Station.* This company tends to offer residences to three artists per year who apply with proposals for art projects which either can be entirely constructed from ordinary refuse or which comment on the nature of consumption and waste. The residence offers a healthy stipend ($400 or so per week/negotiable), a studio space and unlimited fishing for material from any "waste stream".

My Dumpstick was meant to parody the motion and noise of a garbage truck relieving itself. The stick revolved around an axle, at rest it lay horizontally; a person at either end could raise their end quickly until the stick was perpendicular to the floor thanks to a system of pulleys. Letting the stick fall back, the person on the alternating side would lift their end. It was a loud, simple amusement to play with and for me such a pleasure to make something so big and so stupid.

Musicians who make their own instruments should feel welcome to apply for the Artist-in-Residence Program at the San Francisco Recycling and Transfer Station and may call Peggy Hughes at (415) 330-1414 for guidelines or to arrange an artist tour. Residents are expected to talk about their work to the general public and to visiting groups of university as well as grammar school students.

— James Harbison
110 Capp #4, San Francisco, CA 94110

Right: James Harbison's Dumpstick

Left: Another in a series of possible instruments by Ernie Althoff

In the "Notes from Here and There" section of *EMI*'s December, 1997 issue (Volume 13 #2) we included photographs of two of Frank Pahl's peculiar, sound-sculptural automata, entitled Automatic Marimba and Virtual Pet: Gerbil. We were able to include sound recordings of the marimba in *EMI*'s Volume 13 cassette. Since then, Frank has produced a couple of CDs using a peculiar blend of standard and non-standard instruments (euphonium, automatic marimba, whistling, banjo, marxolin, harmonium, ukulele and more on the latest one). At the same time he has continued to make appealingly odd automatic musical devices. He recently sent along this update.

THE DOOR-TO-DOOR DOORBELL SALESMAN SAMPLE CASE

A day hasn't gone by in the past year that I haven't thought about doorbells. This preoccupation began when a friend of mine introduced me to the wonderful world of microcontrollers. A microcontroller is basically a computer that can fit in the palm of your hand driven by a microchip programmed to whatever sequence or set of parameters you choose. I was intrigued by the possibility of sequencing acoustic events. My first microcontroller project was a string quartet made up of ukuleles gently plucked by tinker toy parts attached to slow servo and timing motors. The downside to the project was that, since I'm a mediocre engineer, most of my time was spent aligning the motors with the ukuleles. To sidestep my engineering weaknesses I decided on doorbells for my next project.

The sound of a typical doorbell is created when the cylinder from a solenoid strikes a metal bar. A solenoid is a cylinder around which is wrapped a coil of wire that, when carrying a current resembles a bar magnet. The cylinder is drawn through the coil when current flows. A spring allows the cylinder to snap back into place until the next charge of electrical current. Simple easy-to-read wiring diagrams are often imprinted on the doorbell. A complete doorbell kit should include a doorbell, wire, two pushbuttons and a 16-volt transformer to be connected to a.c. house wiring.

A Door-to-Door Doorbell Salesman Sample Case

My first task was to collect the doorbells. The moths in my wallet suggested yard sales and secondhand shops. I also bought obnoxious buzzers and bells. I'm partial to the NuTone doorbells out of Cincinnati because of their tone and resonating chambers, but for the right price I wouldn't turn my nose up at Trine or Friedlander (cheaper doorbells often have no resonating chambers and suffer from a thin tone). I set my limit at five dollars each and after a few months I had a dozen doorbells from which to choose. When literature was provided I noticed that the manufacturers all insisted that their product only worked properly with 16-volt transformers of the same make even though they all shared the same specs. I wrote this off as shameless propaganda and bought any cheap transformer I could get my hands on. Specs are specs.

The next step was the choice of cases for my doorbells. In my hometown we have a curious tradition called Free Trash Day. Twice a year residents are allowed to put out as much garbage as they want without any additional charge for pickup. I haunted the alleys on these hallowed days in search of '50s furniture, silver Christmas trees and record players, specifically the self-contained, funky-colored variety popular in the '60s. The record players can be scavenged for several reasons. The quiet, variable-speed motors are great for automaton projects that don't require much torque. When gutted, the boxes make great displays for the doorbells and, lastly, the electrical chords were needed for the transformers.

Regarding the microcontrollers: I used Microchip Corp. PIC 16f84 chips, which have 13 control lines; each of these can be defined as an input or an output in software. In practice, I never exceeded five outputs. The 5V DC from the output lines controlled the solid state relays which switched the 16V AC for the doorbells and buzzers. Each doorbell requires its own relay. In addition, I used one line on the microcontroller as an input connected to a doorbell pushbutton, which triggered the start of the program when pushed.

The programming language I used was C, and Michael Rodemer, who introduced me to the microcontrollers, was invaluable when it came to programming. He teaches interactive art at the University of Michigan (http://www.umich.edu/~rodemer). The program, which was written on a desktop computer, then compiled and downloaded into the microcontroller, contained the commands to the chip to turn certain lines on, wait an interval, turn the lines off, etc.

Since doorbells are somewhat limited in pitch I tend to write programs that act as rhythm tracks as opposed to melodic tracks. Almost without exception the interval for inexpensive doorbells is a descending major third, perhaps best exploited by Beethoven in the opening movement of his Fifth Symphony. Bernard Hermann also used the interval to great effect in several of his film scores. If you still feel limited by the descending major third you can either switch the bars and make it an ascending major third or wire it for back door use only which is one note instead of two. Recently I strayed from the doorbell bars and raided a glockenspiel for variety in both pitch and tone. In the future I plan to experiment with cutting the bars that come with the doorbells. Since the tone is so similar to a gamelan and court gamelan music is cyclic and repetitive, I'm tempted to adapt traditional gamelan music to the automatic realm.

My boxes have had a strange life thus far. They've accompanied me on one man band tours and they've been exhibited in art galleries. The name given the boxes is usually dependant on the venue. In universities, where the gulf between high art and low art sometimes seems oceanic, I've exhibited them as Quartets 1-4 with quotations from Stravinsky, Beethoven and the Beatles. I've also shown them in for-profit art galleries under the guise of Door-to-Door Doorbell Salesmen Sample Cases on generous loan from the Nutone Corporation. I'm hoping that writing this article will help me get them out of my system so I don't become known as the doorbell guy. In the meantime I'm enjoying exploring the world of music that exists between the ding and the dong.

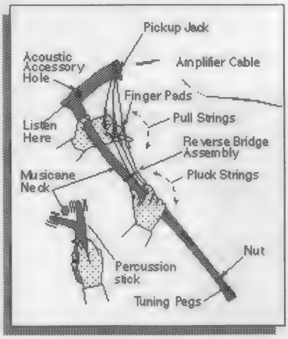
For correspondence feel free to e-mail me at: fpahl@umich.edu

— Frank Pahl

IN EARLY 19th CENTURY EUROPE, there was a bit of a fad for walking-stick instruments — that is, musical instruments made in a form that would allow them to double as walking canes. Wind instruments such as flute, recorder, oboe, bassoon and clarinet were made this way, as were narrow, tubular violins (for which the bow could be stored within).

Len Maurer had been using a favorite walking stick for many years before it occurred to him that the stick was a musical instrument waiting to happen. This cane had helped him with a bad back resulting from a WW II combat injury; it had also served him, at various times, as a practice golf putter, a field hockey stick, a stickball bat, a canoe paddle, an archer's bow, a fishing rod, a stand-up seat in the subway, a martial arts practice weapon, and a thing-for-percussing-upon. Len, who is both an artist and an engineer, had carved it out of wood from a wild cherry tree once growing in New York City's Central Park. Now the stick has become a stringed instrument as well.

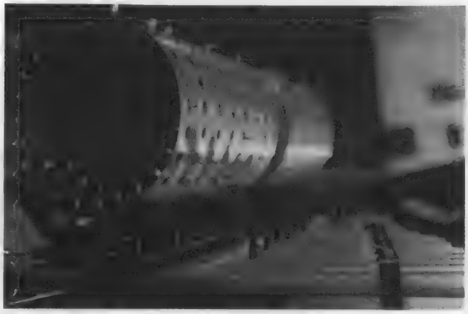
Len's *Versitar*™, or *Musicane*™, as the stick-turned instrument is called, is a unique, tension-controlled, three-stringed instrument, played primarily by plucking (it can also be bowed). As you can see in the diagram, it employs a reverse bridge, with the strings pulling upward against a hook-like mid-string bridge configuration. The fingers of the left hand (or right hand if the bridge is reversed) control the sounding pitch of the three strings by tightening or relaxing their tension, while the right hand plucks. Between the three strings, the total range is over three octaves. Both melodic and chordal playing are possible, and glissando between the tension-controlled pitches is integral to the effect. "For private practice," Len says, "the Musicane can be heard in full-quality 'concert sound' by placing the ear directly against the slight bulge at rear of the handle as if it were a headphone. There is no soundbox, but a thin, gourd-like bowl can be attached to the handle to deliver a rich, long-sustaining sound." The instrument can also be equipped with a pickup, giving a sound akin to a solid-body electric guitar and amenable to all the signal processing tricks that guitarists often employ.



Len has made Musicanes in several sizes and shapes, including a single-string double bass version, all sculpted from fallen branches of hardwood trees found in Central Park. The original has been exhibited at the Museum of American Folk Art as well as New York's Metropolitan Museum of Art, where it will later join the museum's collection of four 19th century walking stick instruments (a violin, an oboe, a clarinet and a recorder). The Musicane is a natural, easily intuitive instrument for playing by ear, suitable for trained musicians as well as those who didn't know they were musicians, and Len envisions producing them and making them available in quantity. The multi-functionality of the original stick is part of the vision: the finished product is to be a string instrument capable of doubling as walking stick, golf putter, fishing rod, and so forth. "Once you have one, you'll never want to go out without it," he says. "Imagine meeting a stranger on the street or in the park with a Musicane, and stopping to play a tune together (or a game of field hockey). What a way to make new friends ... And, as for friendly 'enemies' ... a marital-art 'joust' could be loads of fun ... and great self-defense practice, to boot."

Len Maurer plays his amplified Musicane with the legendary Les Paul (inventor of the Gibson solid body electric guitar) and his trio at the Iridium Jazz Club in New York.

For more information on the Musicane, contact Len Maurer at ENIGAMI associates. 317 West 77th Street, New York, NY 10024, email LeonMaurer@aol.com; or visit http://members/aol.com/versitar/musicane/Musicane.index.html.



Upper two photos: Michael Bradke's Composing Machine. The sixteen tubular bells can be played by putting little pegs in the holes in the rotating drums.

Lower two photos: Tone Tubes. Thirty drums, six horn organs, twenty tubular bells and several "call-in" and "listen-to" pipes. Over eighty meters of plastic pipe. These pipes form an ever-changing, huge sounding pipe system with the help of many junctions. This labyrinth of sound sculptures satisfies not only the kids but also their parents.

SOUND SCULPTOR MICHAEL BRADKE

For the last fifteen years, Michael Bradke has worked with sound sculpture as a meeting ground for music, pedagogy, and cultural transmission. Central to his work are people: people in interaction with sound, in interaction with sound-making objects, and in interaction with one another. Much of his work is designed with children in mind, but it's the sort of stuff from which grown-ups can learn just as much. Fun is always a factor.

Museum exhibits, made in partnership with both adult museums and children's museums throughout Germany, have been one of Michael's mainstays. Most recently he created *Boing!! — Sound-ColorShape*, an interactive exhibition about the connections between music and art at the Children's Museum of the Wilhelm Lehmbruck Museum in Duisburg and Sprengel Museum in Hannover.

On these pages we have photos of several of the Michael Bradke sound installations. Michael can be reached at Fürstenwall 210, 40215 Düsseldorf, Germany; fax 49-211-371963; email Michael.Bradke@t-online.de.

HANS TSCHIRITSCH is a theater musician, a specialist in theatrical sound effects, and an instrument maker working in Vienna. Many of Hans' instruments, like the horned string instrument he's holding in the photograph here, show the influence of the Stroh violin, in which the vibration of the bridge drives a small diaphragm at the base of a phonograph-style horn. Influence of the hurdy-gurdy is in evidence too, reflected in the bowing wheel on the instrument he's holding, and in the wheel on the oversized violin behind him as well. On the far side of that giant violin is another unusual feature, not visible in the photograph: a curtained doorway. Listeners can enter the sound chamber to hear the instrument speak with a satisfyingly resonant, overtone-rich roar as the bowing wheel turns. Some of Hans' other instruments include beautiful large-bore bass horns (influenced, in this case, by didjeridu but differing in appearance, tone, and certain facets of the playing) and whirled instruments in propeller-like configurations.

Hans Tschiritsch can be reached at Alserstrasse 10/8, A-1090, Vienna, Austria, or by fax at ++ 43-1-407-89-82. The CD

Photos these two pages:

SOUND INSTALLATIONS BY MICHAEL BRADKE

Upper two photos: Water Orchestra. Thirty water instruments, including Splish-Splash-Piano, the Diving-Gong, the Bottlephon, the Plop-Pipes, Water-Organ and a huge Pot-Drumset (Waterdrums). The watery instruments can be installed in shallow water or on any water-resistant surface. The resulting water-music compositions are a great way to bridge the gap between the generations.

Lower left: Pressure Drum. The tension on the drumhead increases when the seat is pushed back.

Lower right: The Earth Xylophone.

Propeller by Tschiritsch's Urwerk (RST Records; RST #91625) features Hans and his instruments in ensemble with a group of Caribbean, middle eastern and Austrian musicians centered in Vienna.

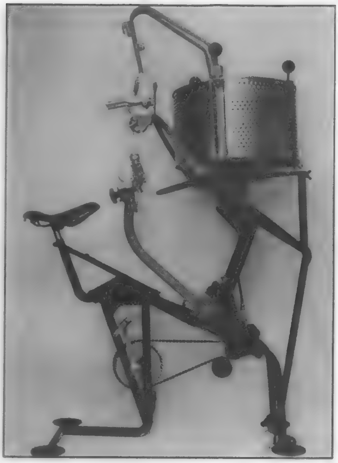
At right:

Hans Tschiritsch holds one of his phono-fiddle/hurdy-gurdy-like instruments, with a giant hurdy-gurdy/fiddle behind him. In the background can be seen a few more of his instruments.

Photo by Dworschak

THE HUNGARIAN INSTRUMENT MAKER VIKTOR LOIS produces extraordinary string and wind sound constructions of metal. They have recently been shown at the Tatabánya Szabadtéri Bányászati Múzeum (The Open-Air Mining Museum of Tatabánya, former XVth shaft, 2800 Tatabánya, Vágóhid u., Hungary). From that exhibit comes a catalog full of beautiful photographs of the instruments, and we have reprinted a few of them here.

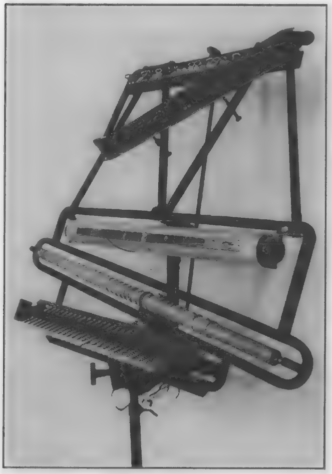
The catalog is titled *Hangfürdö: Soundbath Permanent Exhibition* (ISBN 963 85830 10, 1998). *EMI* thanks the museum as well as the publisher and photographer István Dallos for permission to reproduce the photographs.

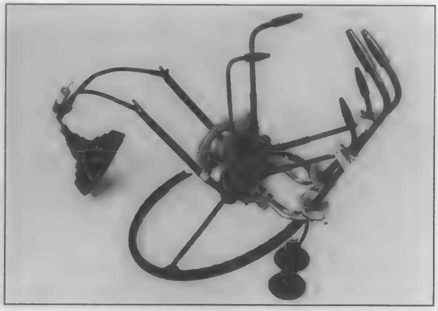


Right: Washing-Siren. Here is a washing machine drum mounted on elements from a bicycle frame. Three strings are mounted around the periphery of the drum. It's unclear from the catalog description just how this one works; adding just a bit of mystery to the strangely evocative sculptural form. (height: 164cm) Photo: Dallos István

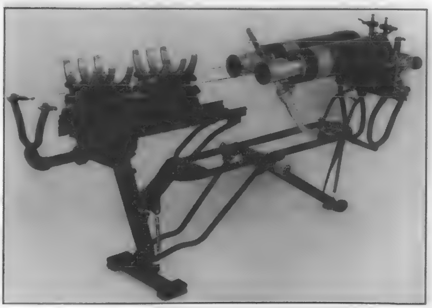
Below, top left: Twenty-Two Stringed Pipe-Rubber. Pressing the keys of the keyboard below brings the strings of the instrument into contact with the rings on the roller above the keyboard. A motor behind the gear at the center keeps the roller rotating, sounding the strings by friction. (height 166cm) Photo: Dallos István

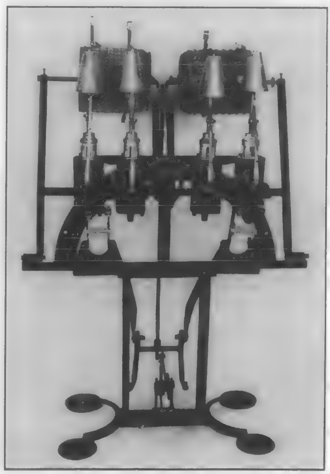
Below, top right: Gas Pipe. The main elements here are nozzles from a gas welding apparatus. This is a wind instrument incorporating two fife systems, controlled by switches. (height 55cm) Photo: Dallos István





Lower left: Legendary Bass Guitar. The two strings on this instrument can be "fretted" using the metal keys as tangents. (Height 70cm) Photo. Dallos István





Lower right: Acoustical Drum Machine. A sewing machine foot-pedal arrangement turns the two upper drums. Mounted in the drums are hammers which sound the cowbells. (height 143 cm) Photo: Dallos István

NEWS FROM *LES PHÔNES* IN BELGIUM

Perhaps you've discovered the Belgian musical group Les Phônes through the CD *Orbitones, Spoonharps & Bellowphones* or their first CD *Mythes & Legendes Phônes*. In these pictures you can see the members of Les Phônes working in their studio with a part of their new material: The latest evolution of their stiltophones (the instrument which sounds when you move or dance on it) with new telescopic flutes, clutch keys to allow the player to make movements with no sound by letting the air out of the flutes before the whistles ... and the new "vibrating double flutes with continuous blowing bellows" called "butterfly."

Having in the past used only instruments that they themselves have made, the group now mixes their instruments with others not of their own construction (bass clarinet here, but also violin, guitars ...), as well as the ancient didjeridu (very close in spirit to the stiltophone). Together, these elements add up to a very interesting combination of our classical tradition, their new mythology, and one of the oldest cultures in the world.

Add to this the philosophico-political songs they are currently working on, and you can wager that a very open and interesting project is in the works. Les Phônes has announced that it will take the form of two new CDs to be published in a few months.

Franck Pillonetto (the leader of Les Phônes) is also working with the stiltophones on a project with the Royal Conservatory of Music in Liege for a concert in tribute to the contemporary composer Henry Pousseur. It's interesting to note that such an instrument could have entered this kind of musical institution.

Frank Pillonetto and Les Phônes can be reached at Rue St-Gilles #26A, 4000 Liege, Belgium.

Photos on this page:

Members of Les Phônes with instruments both new and traditional.

Photos by Leopold Baiwir

Glen Peterson, himself a maker of tromba marinas, recently attended a lecture on the instrument by Cedil Adkins. He sends this report.

A TROMBA BY ANY OTHER NAME...

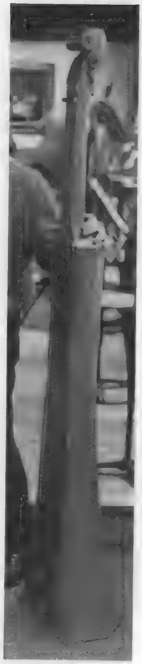
Cecil Adkins' lecture on the Tromba Marina at the Museum of Fine Arts, Boston, 2/3/99.

On the day of Cecil Adkins' lecture, there were three tromba marinas in the musical instruments room at Boston's Museum of Fine Arts, two in playing condition! The tromba marina, which had its day in Europe between the 15th and 18th centuries, is usually over six feet tall, and roughly conical, with a flat belly sporting a single playing string and a bridge that is designed to rattle against the body, producing a high trumpet-like sound. The player bows the instrument only an inch or so from the nut, and touches the string lightly with his thumb between the bow and the bridge, producing harmonics. The tromba marinas used in the demonstration had 50 sympathetic strings, all tuned to the same note as the playing string. The instrument is designed to sound the upper partials of the long playing string, giving it about 20 notes, spread over 4 octaves. Only about half of these notes play strongly and in tune.

The sound of the instrument is difficult to describe. The 50 sympathetic strings give it a subtle celestial ring, while the trumpet

bridge produces a cutting trumpet-like melodic buzz. Most notes are very slow to speak, and short bleeps and squawks are not unusual, making the whole effect strange and otherworldly, rather than heavenly. Playing it seems more like coaxing a wild animal than operating a fine machine.

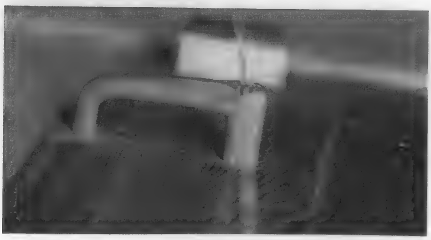
Dr. Cecil Adkins is the Regents Professor of Music at the University of North Texas, and author of the only full-length English text in print on the history of the tromba marina. Dr. Adkins spoke for at least an hour and a half about the instrument. First, he explained that the instrument underwent several name changes: first it was called a Trumscheit, then Tromba Marina or Marine Trumpet, then Nonnengeige or Nun's fiddle. It seems the word "Tromba" is related to the German words for drum, and trumpet, probably because the bridge drums on the belly of the instrument and sounds like a trumpet. Marina on the other hand has no real meaning related to this instrument.



Above: Cecil's instrument.

Right: Sympathetic string tuners with decorative cover slid away. Playing string in foreground. Note the bridge adjustment peg in lower right. It's connected by fishing line to the bridge, several feet away, and adjusts the horizontal tension.

Below: Bridge on Cecil's instrument. Note horizontal bridge tension string on the right.



Tromba photos by Glen Peterson, with help and developing by Matt Samolis.

That settled, he demonstrated the parts of the instrument and the scale that it played. Cecil and his daughter Madeline proceeded to play duets which was very special, but the high point was hearing Madeline perform Sonata no. 1 from "Suonate per la Tromba Marina" by Lorenzo de Castro. What a thumb! I was surprised what interesting music could be written for an instrument of so few notes. Most of the pieces Cecil and Madeleine played were written between 1660 and 1770 and sounded very fanfare-like.

It was a once-in-a-lifetime gathering of tromba marina information and I would like to thank Darcy Kuronen for organizing this lecture. If you want to learn more about tromba marinas, try the sources listed below:

Ancient European Musical Instruments, by Nicholas Bessaraboff. Published for the Museum of Fine Arts, Boston, by the Harvard University Press, 1941. This expensive ($285 used) volume contains three pages of excellent information about the tromba, including measured drawings of the instrument in the museum's collection. Look for it in your local library.

A Trumpet by Any Other Name: A History of the Trumpet Marine, by Cecil Adkins and Alis Dickinson. Rumor has it that the German book firm "Laber" has copies of this book.

"The Trumpet Marine," by Michael Meadows, in *Experimental Musical Instruments* Voume 3 #2 (August, 1987).

New Grove Dictionary of Musical Instruments, Standley Sadie, ed. 3+ pages including extensive bibliography in the entry under "Trumpet marine" written by Edward H. Tarr.

THE WINSLAPHONES

Richard Johnson has recently sent along this photo and these notes on a brass player's dream.

The Winslaphones, invented by Richard Johnson and built by Dick Hansen, is an instrument that combines many varied timbres. It is designed to switch from one sound to another almost instantly and create combinations never heard before.

The tone is produced either by a trombone or trumpet mouthpiece or a bassoon reed, and passes through a trombone slide to control pitch. There are three valves and a trigger played by the left hand which send the air to five different bells or a melodica. Each bell produces a distinct color, somewhat like the sounds of a baritone, muted trombone, horn and trumpet. The melodica has a keyboard played by the right hand and sounds like a harmonica.

Inventor Richard Johnson and builder by Dick Hansen with the Winslaphones (which has evolved a bit further since this photo was taken).

To produce some special effects, the melodica can be played at the same time as one of the small bells, or the trumpet and trombone mouthpieces can be played together through the sides of the mouth. There is also a small toy siren which can sound by itself or with the horn bell. The many sounds can be combined in an almost infinite number of ways. Hopefully this instrument will invite composers to think about new sound possibilities and expose listeners to exciting aural adventures.

BILL REID (breid@prairie.globaldialog.com) writes

I am a steel sculptor trying to add more noise in general to the sculptural pieces I've been making [see the photos at right]. They are made out of sheet steel welded with an oxy-acytelene torch. *Flabongo* has nice sound coming out of its body. Both it and the *bee guitar* have a real metallic sound and are tunable. The bees on the flower of the bee guitar are the pegs. I'm making a catfish bass guitar now and hope to make something along the line of Russolo's intonarumori.

Bill Reid's Bumble Bee Guitar (48" tall) and Flabongo (30" tall)

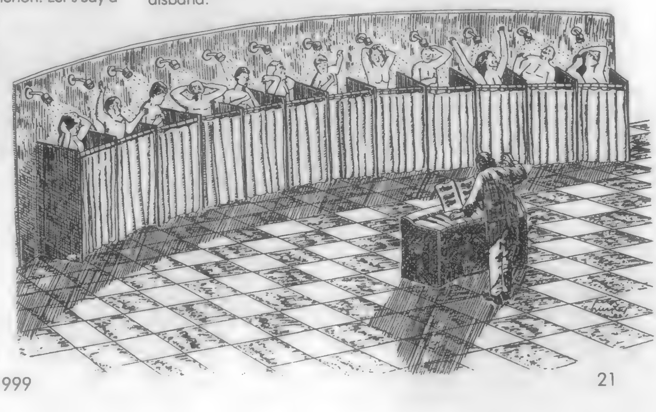
In response to discussions of and pictures of cat pianos appearing *EMI*'s letters section a few years ago, Peter Hurney has sent this report on one of his recent projects.

THE COLD WATER SHOWER REACTION DEVICE,
OR *THE SCREAM*

Inspired by the Howling Cat Box seen in *EMI*, we, with funding procured from the European Music, Arts and Science Guild, proceeded to devise, assemble, audition and perform what came to be known as the Scream but is officially called "the cold water shower reaction device." Based on the elementary premise that practically everyone in the bathing world would be aware of that when an otherwise pleasant shower is interrupted by a cold stream of water a sudden physical reaction, usually accompanied with an acute audio emphasis, occurs. Armed with this immutable fact we proceeded to audition a cast of "singers". We were seeking people who, when their shower was deprived of its warm water, would scream in tune and exactly on pitch to a note coinciding with one in our western musical scale. While auditioning and experimenting we observed an interesting phenomenon. Let's say a Performer would sing a C sharp when their water supply changed from a warm 122°F down to a cool 70° F . We observed that the same person would sing the same C sharp pitch yet an octave higher when the water temperature was dropped to an icy 40°F, kind of like an overblown horn effect.

With this information and with a dozen members chosen as "singers", we had a complete two octave range. We proceeded to construct our portable showering apparatus which consisted of a dozen individual shower stalls, a master controller resembling a massive keyboard with each key controlling the water flow through a series of simple electromagnetic solenoid valves. Through this controller the conductor could control the temperature of the water flow to any of the individual showering performers to be anywhere from the comfortable 122°F to the cool 70°F down to the downright icy 40°F with the touch of a key.

It worked like a charm . After some weeks of rehearsal and a little fine tuning of the apparatus our twelve singers and the conductor were ready for public performance. We had chosen to use castrati to sing the very highest of notes and since Italy's lawmakers had unfortunately recently passed some anti-cruelty to alterboys legislation we had to skip over our Papal States performance dates, which was lamentable since we had rehearsed some beautiful secular tunes with Italy in mind. We had filed some paperwork attempting to get artist immunity for our planned Italian performance dates and in the meantime were playing other major European cities to very good reception and with good reviews. Then catastrophically our warm shower apparatus was confiscated by the government in Helsinki so that hot water showers could be made more available to their needy citizens. Some payoffs must have been made because there seemed to be no legal recourse to our plight and we were forced to cancel the rest of our European tour and disband.



GLOBULAR HORNS

by Barry Hall

Globular horns are very uncommon instruments. Technically, they are a family of buzzed-lip aerophones, related to trumpets and horns in the same way that ocarinas, or globular flutes, are related to tubular flutes. However, although a technical category exists for them, I have not yet encountered any other instruments of this form except for those I have built.

I like experimenting with different instrument forms blending the aesthetic with the acoustic, and looking for new ways to expand traditional instrument systems. I've had a lot of fun exploring globular systems and integrating them with other instruments, and I'd like to share with you some of my observations and discoveries, as well as descriptions and photos of some globular horns I have built.

TUBULAR VS. GLOBULAR

Let's first talk about flutes, because it will help me explain globular horns by analogy. Most people are familiar with a tubular flute. It's typically a hollow tube of wood, metal, or bamboo, usually with *toneholes* (finger holes), and with a blow hole on the side (in the case of a transverse flute), or with a *fipple* blowhole on the end (as with a recorder or pennywhistle). A different type of flute is a globular flute, also called a vessel flute. "Ocarina" is a common name for one of the most common types of globular flutes. Unlike their tubular flute cousins, globular flutes can be any shape, but still have finger holes and a blow hole, and are played in generally the same fashion as a tubular flute. But that's where the similarity ends.

The physics of sound production is significantly different between tubular and globular instruments. In a tubular instrument, a vibrating column of air produces the sound. The length of this air column is the primary factor determining the pitch. However, the pitch can be modified by uncovering toneholes along the body of the instrument, which effectively shorten the length of the air column and raise the pitch. But with globular instruments, the shape of the air contained within the vessel is generally irrelevant to the pitch. It's the total volume of air contained in the vessel and the size of the opening that determines the pitch. (The system at play here is commonly called at Helmholz resonator. Look it up in an acoustics book or Bart Hopkin's *Musical Instrument Design* book for more details on how Helmholz resonators work.) So what this means for flute design is that with a tubular flute, the size of the toneholes and their position relative to the end of the tube influences the pitch change that results from uncovering the hole. However, on a globular flute, the size of the tonehole has a similar effect, but the location of the tonehole has essentially no effect on the pitch.

Another difference between the two systems is that tubular instruments can play overtones. A bugle, for example, has no toneholes but can still play a whole set of pitches, determined roughly by the harmonic series of overtones above the instrument's fundamental pitch. This is the same principle that allows you to play multiple octaves on flutes and whistles. By blowing harder and altering some other factors, you can cause the instrument's tone to jump to the next octave. However, it's not possible to play overtones on globular instruments. Because of this, their pitch range is typically much more limited than their tubular cousins. For example, most ocarinas have a range of less than an octave plus a third, while tubular flutes commonly have a range of more than two octaves.

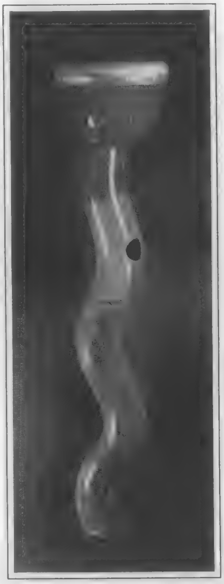
Now let's move on to horns. The most common types of horns today are members of the brass family – trumpets, trombones, French horns, tubas, etc. These are all tubular horns because they have a long conical or cylindrical tubular air column. They operate in a manner similar to a tubular flute except that the air column is excited into vibration by buzzing lips rather than by air blown across an aperture. So if we have tubular horns, then we should also have a class of globular horns, right? Well, I don't know of any, past or present. If you do, I would love to hear from you. Why are they so uncommon, I wonder?

THE BASIC GLOBULAR HORN

My personal discovery of globular horns began while experimenting with a type of traditional Nigerian ceramic percussion instrument called an "udu" (pronounced OO-doo). Among musical instruments, the udu is perhaps one of the purest forms of a Helmholz resonator. As you can see from the photo, an udu is a clay pot with a side hole. It is played using a combination of hand strokes, most commonly by striking the side hole of the pot with

Above: an udu.

Below: a globular drum-horn.



Above, left and right: hybrid globutubular horns
with goatskin resonators and side-blown mouthpieces.

Below: hybrid globutubular horn with globular sections at both ends of the tube.

the palm of the hand, which produces a single deep, pitched note. Technically this makes an udu a "plosive aerophone" because the sound is produced by air vibrating in the globular chamber, and the air is excited by a percussive strike of the player's hand. However, an udu can also be played as a globular horn, by blowing into the side hole with buzzed lips. When a creative percussionist friend of mine picked up an udu I had made and discovered this, my fascination with globular horns began.

My initial globular horn designs were based on the shapes and proportions of udus. I adapted the basic udu design for playing as a globular horn by adding a mouthpiece rim. These instruments, when blown with buzzed lips like a brass instrument or didjeridu, are very resonant at a single pitch. They have a very nice hollow, ringing timbre, which can be augmented with higher partials to produce an edgier sound by manipulating the air cavity within the player's mouth. I also experimented with finger holes,

like in an ocarina. These were only marginally successful, as they seemed to compromise the strong resonance present in the fundamental pitch of the instrument. When describing globular horns with tone holes, I'm reminded of the expression about the renaissance cornetto family (instruments played, trumpet-like, by buzzing the lips, but with side holes in place of the modern valves), which says that "opening a tonehole doesn't make a pitch happen, it just makes it somewhat more likely to happen." As a result, most of my globular horns do not have finger-sized tone holes. However, I have made a few globular horns with palm-sized tone holes. These large tone holes seem easier to control, but still compromise the instrument's tone somewhat.

The combination of the large size of my globular horns, which necessitates large mouth openings, their relatively low pitch, and the open (as opposed to cupped) mouthpiece design lends these instruments to a playing style similar to the Australian didjeridu. Also the fact that they are, in the absence of toneholes, capable of producing only one note, makes them candidates for the many varieties of articulation, harmonics, vocalizations, and other creative techniques commonly used by didjeridu players to enhance the basic drone. (In fact, multiple notes can be produced on many of my globular horns by several methods including "lipping", sticking your hand in the bell or neck, and, in some cases, overblowing.)

At the time I began exploring globular horns, I was also making udus, doumbeks (goblet drums with skin heads) and ceramic didjeridus, so my next steps were to experiment with combining aspects of all three of these instruments into hybrid creations. Descriptions of several of these hybrid instruments follow.

HYBRID 1: THE GLOBULAR DRUM-HORN

Adding a goatskin membrane to the side of the basic globular horn chamber creates a hybrid drum-horn. When striking the membrane with one hand as a drum while opening and closing the mouth hole with the other palm, the fundamental pitch of the drum is modified. Since the drum's fundamental pitch (based primarily on the resonance of the air cavity within the Helmholz-like chamber) is quite prevalent in these goblet-style drums, this instrument can produce a very effective bass line when played in this manner. When playing this same instrument as a globular horn by blowing into the mouth hole, the membrane seems to vibrate synchronously with the pitch of the instrument. This has the effect of reinforcing the pitch and increasing the volume of the instrument, as well as enriching the tone by adding some additional complexity to the timbre. It also causes the instrument to continue sounding for a short time after you stop blowing. In addition, the "buzz technique" can be employed. (See the sidebar, "What's the Buzz?")

HYBRID 2: THE GLOBU-TUBULAR HORN

Combining globular and tubular sections in a single hybrid "globu-tubular" horn is surprisingly effective. A relatively small globular section at the beginning of a tube produces a pitch much lower than a tube of the same length. This allows for the creation of very low-pitched instruments that are surprisingly compact. Moving the globular section toward the exit end of the tube decreases its pitch-lowering effect. A globular section at the very end of the tube doesn't lower the pitch at all, but acts as sort of a reverse bell or resonator, creating a hollow, constipated timbre.

So why do the two systems—globular and tubular—integrate so well in the same instrument? I'm not sure. Initially I thought perhaps the globu-tubular horn was really just a pure globular horn with a very long Helmholtz "neck". But I've discovered that these instruments have unique characteristics of their own. For example, unlike globular instruments, you can play higher overtones on these hybrids. The pitch of the overtone seems to be primarily related to the length of the tubular section. Perhaps the globular and tubular sections of the horn act quasi-independently in producing overtones, with the globular section communicating the impulses necessary to set up a standing wave in the tubular section.

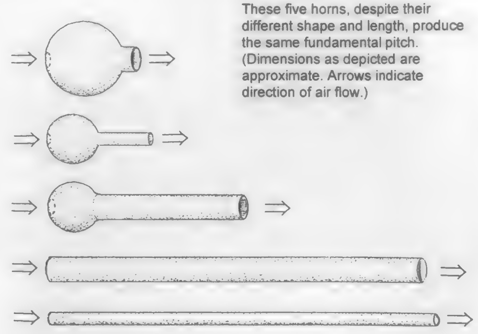
WHAT'S THE BUZZ?

An interesting and fun technique that can be used when playing globular horns with resonating membranes is the *buzz technique*. It's very simple...when blowing into the horn, lightly touch your finger, fingernail, or another object to the surface of the vibrating membrane. Depending upon the object, where you touch it to the membrane and how hard you press it against the membrane, you can achieve a variety of loud gritty buzzing effects. Adding a snare to the drum head, perhaps with a tensioning peg, can achieve a similar effect, but with less flexibility for tone modification.

I believe this technique is effectively converting the instrument into a mirliton. (Mirlitons are instruments with diaphragms that buzz. An example is the kazoo.) How does the globular horn become a mirliton? When it's not obstructed, the membrane vibrates sympathetically (as much as it can) with the frequency of the pitch the horn is producing. But if you use your finger or other implement to obstruct the vibrating head, you effectively clip the sound wave; you keep the membrane from traveling to the apex of the curve of its frequency wave (on one side only). However, I think it's not so much the altered sound wave you hear, but the new pseudo-pitch created by the regular rhythmic "tapping" of your finger on the membrane. A constant regular clicking sound, if rapid enough, will be perceived by one's ears as a pitch.

An interesting discovery is that on most instruments I can get at least two different pitches by manipulating my finger that is touching the head. One is the pitch of the fundamental note, and the other is an octave lower. I believe that the lower pitch is produced when my finger, bouncing away from the membrane, contacts it only once for every two cycles of the frequency wave...that is, it skips every other cyclical vibration of the membrane, which halves the frequency of the resulting pitch perceived by our ears.

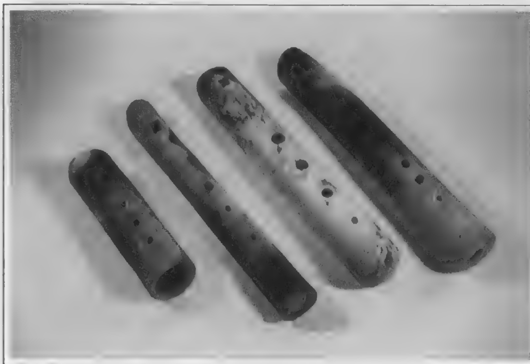
At first I thought it would be quite interesting to explore this characteristic in more detail, using multiple-pitch globular horns to create variable pitch kazoos. However, upon reflection I decided it was a rather silly idea, since normal "voice-activated" kazoos have a wide pitch range, limited only by the vocal range of the kazooist!



These five horns, despite their different shape and length, produce the same fundamental pitch. (Dimensions as depicted are approximate. Arrows indicate direction of air flow.)

Above: a globular fiddle-horn

Below: Although these may look like tubular flutes, they are all globular flutes.



Additionally, vocalization — the technique of singing into the horn while playing — is more pronounced in these instruments than in purely tubular horns. I can think of two explanations. First, there is a much shorter distance from the mouthpiece to the bell than in a longer tubular instrument. And second, the resonances in a globular horn may be less well defined than in a tubular horn, allowing more of the original character of the voice to come through. (If this isn't clear, try singing into a long tube and see how it colors the tone of your voice as well as influences the pitch of your voice based on the tube's set of narrow, well-defined resonance peaks.)

HYBRID 3: THE GLOBULAR FIDDLE-HORN

The globular fiddle-horn is an instrument I affectionately call the "fiddle-dee-doo". It's a globu-tubular horn, with a goatskin resonator. The tubular section of the horn is the neck and fingerboard of the fiddle, and the goatskin membrane on the globular section is the soundboard of the fiddle. It can have one or two gut strings. The blow hole for the horn is on the back of the globular section. While it can be played as a globular horn or as a fiddle, it's most interesting when the two systems interact. For example, when blowing into the globular horn, the strings of the fiddle vibrate sympathetically. The next version of this instrument will be designed so that the fiddle and horn can more easily be played at the same time. Like other globular horns with goatskin resonators, it can also be played as a drum.

GLOBULAR AND TUBULAR TRADE-OFFS

The diagram above left shows cross sections of five different horns. The round segments of the horns are spherical globular chambers and the other sections are cylindrical tubes. Horn 1 is a globular horn; 4 and 5 are tubular horns, and 2 and 3 are hybrids. Despite their different sizes, shapes, and air volumes, all five instruments produce the same fundamental pitch. Notice that the diameter of the bore of a tubular horn has little impact on pitch (compare 4 and 5), but the bore of the neck opening on a globular horn significantly impacts the pitch (compare 2 and 3).

CONCLUSION

There is much fertile ground left to be explored here. What are the practical instrument-building principles or ideas you can take away from this article? I'll summarize a few of my insights that may stimulate some creative ideas and experimentation, or perhaps some modification of instruments you may have already created:

1. Globular and tubular aerophone systems are different, but similar.

2. You can add a globular component near the beginning of a tubular instrument to lower its pitch, or add one near the end to alter the instrument's tone.

3. Widening or narrowing the bore of a tubular instrument has little effect on pitch.

4. Widening or narrowing the neck of a globular

instrument has a significant effect on pitch.

5. With tubular instruments, pitch is affected by the size of toneholes and their distance from the end of the tube. With globular instruments, pitch is affected by the size of toneholes but not their location.

6. Flexible membranes can alter aerophone characteristics and reinforce fundamental pitches. They can also provide additional sound-producing mechanisms in the style of mirlitons.

Thanks to Bart Hopkin and his excellent book *Musical Instrument Design* for information on Helmholz resonators, globular and tubular systems, and mirlitons. And thanks to EMI, its readers, Dr. Elizabeth Hall, Richard Smith, Geoff Brown, Dr. Guy Grant and the internet didjeridu community for inspiration and encouragement.

Barry Hall leads the Burnt Earth Ensemble and builds the group's ceramic musical instruments. His instruments and music are featured on "Gravikords, Whirlies and Pyrophones," "Didgeridoo USA" and "Didjeridu Planet." For more information please visit http://www.ninestones.com/burntearth.shtml *or call (925) 947-5537.*

GLOBULAR/TUBULAR AMBIGUITY

When is a tube not tubular? A tube is also a vessel, right? Think of the opening at the far end of a recorder or whistle as another tonehole, and you have a long slender vessel flute. But does it act like one? No, not really, because the diameter of the tube, relative to its length, is very small. But as you increase the diameter of the tube, decrease its length, and decrease the size of the end hole, you start to turn a tubular flute into a globular flute. And somewhere, right on the edge between the two, you have a very interesting and ambiguous instrument.

You can make a "false tubular" flute, with a bore that is rather wide relative to its length, and an end hole that is smaller than the diameter of the tube. This instrument will appear to operate like a tubular flute as you finger up and down the scale, but in reality the pitch changes are due only to the size of the holes, not their relative position. So you could achieve the same ascending and descending scale by covering the toneholes in a different order. Try *that* on a tubular flute!

GOOD THINGS AVAILABLE FROM EXPERIMENTAL MUSICAL INSTRUMENTS

Subscriptions to the quarterly journal are no longer available, since we'll no longer be publishing it, BUT we still have lots of good things available, with more to come during the coming months & years. Right now we have:

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we've kept them all in print

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all but the earliest volumes of EMI's annual cassette series remain available

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FREENOTES FROM RICHARD COOKE

A photo essay, with notes by Bart Hopkin

Freenotes. This is the Freenotes idea at its simplest and most basic: a set of bars, each mounted on its own resonator, which the player can select and arrange at will for playing.

Richard Cooke makes mallet percussion — marimba-like instruments with bars of wood or aluminum, often in beautiful, naturalistic forms and configurations. He calls his instrument-making enterprise Freenotes, a name which comes from one of his design ideas: In his most popular instrument type, the bars come in sets tuned to different scales. Each bar is mounted parallel to its own resonator tube, and each tube-and-bar assembly is separate and independent, not locked into a larger framework. The notes are thus free; they can be selected and laid out in whatever configuration the player wishes, be it a scalewise sequence or some other musically suitable grouping.

The Freenotes concept not only frees the bars from each other but also sets the player free from the difficulties of physical technique and the chromatic scale. This, Richard says, "allows the language of music to be expressed more by feeling, intuition and simply being in the moment than by hours of disciplined practice. The result is a satisfying experience playing music regardless of one's level of experience." It's Richard's belief that enhancing musical creativity leads to greater creativity in other areas of life as well.

Shimmer-Imba. Part of an outdoor installation in City Park, Moab, Utah. The bars are aluminum and tropical hardwoods of various species. The paired aluminum notes are tuned a half a step off so as to create an entrancing waver effect. The instrument is five feet long, and the curve is designed to reach out and embrace the player within the sound. It's set in a pentatonic scale of G major.

Richard also produces larger instruments with permanent or semi-permanent mounting configurations. On these the bars may not be individually free in the same sense, but with their sculptural forms seeming ready to rise to the sky on wings spread wide, the name Freenotes is equally apt.

In *EMI*'s March 1996 issue (Volume 11 #3) we had an article written by Richard Cooke devoted to the topic of marketing for unusual instruments (an area in which Richard has shown good insight). It was a fine article and I recommend it highly — but it was not designed to show off the instruments themselves. Now, in the photo-essay on these pages, we take the opportunity to present these beautiful and imaginative instrument forms in all their diversity.

Drawing by Robin Goodfellow

Above: *Free the Freenotes*. Velcro strips on a circular wall rack allow the bars of this diatonic scale to be positioned in any geometric shape — a concept designed to undermine the tyranny of linear arrangements ubiquitous in keyboard instruments.

Left: *Five instruments of the Freenotes Gamelan*. Pictured clockwise from top: Amandinda, Sunset on the Yantzee, Imbarimba, Moonlight Cyls and, center, the Wing.

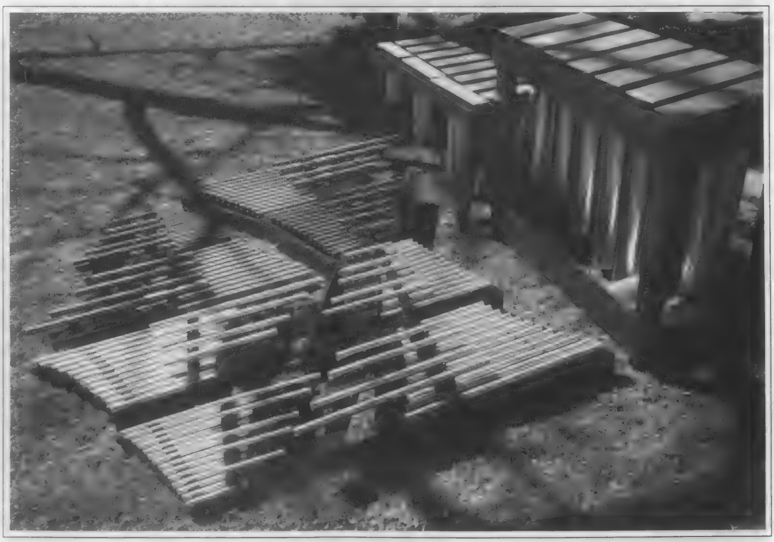
The Manta Ray. A conduit metallophone. The frame, too, is steel conduit, with the tubes suspended from coated steel cable. The same scale is mirrored to the right and left sides, but with the note pairs tuned slightly apart to create a wavering effect when they sound together. The range is two octaves and a fifth; the scale is lydian.

The Thunderbird. A two-octave paired-diatonic Freenotes set, seven feet in length. Once again, the note pairs are slightly detuned to produce a wavering effect when sounded together. Fifth and octave bass drones are at the center. The set is wall-mounted and tuned in Bb minor.

The maker, Richard Cooke, playing with a full deck — the *Redwood Amadinda Deck.*

Above: *Imba-Uumba*: Redwood and aluminum bars on a stand of cedar.

Right: *Kiva Entrance*. Wall-mounted redwood and aluminum Freenotes in a 12-foot diameter circular Kiva built for author Robert Fulghum in 1995. The total length of this instrument installation is thirty feet, wrapping the entire circumference of the interior. The instrument is designed to incorporate musical experimentation within a spiritual and ceremonial context.



Right: *Old Granddad Gamelan*, built for Lou Harrison in 1997. Aluminum and steel tubes and plates with PVC resonators. This is a duplication of one the first American gamelans in just intonation. The instruments of Bill Colvig and Lou Harrison's original Old Granddad gamelan were showing signs of age and the wearing effects of numerous concerts. Richard Cooke's reconstruction, complete with wheeled packing crates, was commissioned to allow the continuing performance of Lou Harrison's gamelan music in concert.

Richard Cooke and Freenotes can be reached at PO Box 1492, Moab, UT 84532, phone (435) 259-4411, email Freenote@lasal.net.

INSTRUMENTS BY BRIAN RANSOM
Above: Ceramic Dragon Congas
Below: Ceramic Shakers

JOURNEY THROUGH SOUND AND FLAME

A ceramic musical instrument maker

By Brian Ransom

The following is a brief collection of memories, thoughts and anecdotes of a musical instrument maker. My first instrument making experience was in 1973. I was regularly playing the flugelhorn in an avant-garde jazz ensemble (whose name I now have forgotten); the only other player whom I distinctly remember was a brilliant young composer and trumpet player named Stephen Haynes (I later named my first son as his name-sake). We were all students at the time, at the Rhode Island School of Design, and making early classes after late night performances was always a problem. As a young composer myself, I was perpetually engaged in searching for musical sounds, tonalities and scales which weren't available on conventional instruments. In retrospect, I think the first flutes I made were partly designed to appease my ceramics class requirements and partly to satisfy my composing desires.

The first instruments I made were a couple of ceramic harmonic flutes. (At the time, I didn't realize that their scales were based on harmonic overtones — I felt as if I was the lone discoverer of these tonalities!) Several distinct impressions remain with me in utter clarity from the experiences of making those first ceramic flutes. First was the amazing tone color of the ceramic. I knew that different materials affected the resonance and production of soundwaves; however, I was astonished by the unusually hollow and haunting sound these ceramic musical instruments produced. My second realization spurred by creating those first clay flutes was that I had stumbled upon a great abyss, a frontier of undiscovered tonalities! Through infinite choices of pitches and sounds, I found my way into the mysterious world of microtonality. The most troubling aspect of ceramic musical instrument making I found was coming to terms with the problem of shrinkage. The tuning phase of most clay instruments (with the exception of idiophones and mebranophones) is in the leatherhard working state, which is before the firing process. In the firing process that follows, different amounts of shrinkage occur in small and large instruments. In small instruments, the pitch rises a small amount; in larger ones, the pitch rises increasingly. I have spent many subsequent years developing a cannon of shrinkage for my specific clay body.

In the last two years of the 1970s, I was fortunate enough to receive a Fulbright/Hays congressional Fellowship for the study of preColumbian musical instruments in Peru. My approach to how and why I make instruments was significantly changed in many ways during the two years I spent in South America. Perhaps the most important revelation I came to was an empathy for the ancient Peruvian idea of animism which adheres to the belief that life force, in the form of spirits, can be found in all things, animate and inanimate. My studies included hundreds of hours in museums and collections documenting ancient instruments as well as ethnographic field work in rural communities throughout Peru.

In Portland, Oregon, during the early 1980s, after I had returned from living in Peru, I formed my first complete ceramic ensemble. The

musicians in the first ensemble were unforgettable. After being enticed by the unique sounds of my ceramic drums, I was joined by master Ghanian drummer Obo Addy. Other musicians included bassist Patrick O'Hearn, saxophonist Rich Halley, Bruce Sweetman, Brian Davis and Bruce Smith. Our first performances were art events which melded dancers, original music, elaborate stage lighting, and some theatrics.

As the years progressed, so did my academic accolades, but mostly, so did my ceramic musical instruments. Most of the instruments I have made, have gone through countless generations of improvement. Voicings in the ceramic ensemble through the years include single, double and multiple whistles and flutes, a variety of invented horns (in particular, the ceramic flugelhorn), reeds (my favorite, the sax-o-snake), strings (including low, bass-like instruments as well as higher pitched harps which utilize silk koto strings), microtonal bells, percussion ranging from bull roarers, rattles and rainsticks, to directional congas, djimbes and invented percussive forms.

Some of the ceramic instruments I make are interactive, and some are based on the natural resonance of chambers. The first of these interactive series were "Activated Ceramic Resonators" which were pieces intended to be touched and played by viewers. Some were activated by electronics, some by blown air using internal fans, and others by the action of moving water. The most recent series of this type that I made were ceramic resonator vessels which I installed into a specific space (so far, two different art galleries). These resonators activate the standing wave or resonant pitch in the chamber and are powered by tone generators. The result to the viewer is a space which is geographically perceived through sensations of sound. When you walk through the installation, you sense the physical waves of sound as an environment — the viewer is actually composing by choosing a walking path throughout the sounding resonators.

Throughout the late 1980s and early 90s, I lived in Los Angeles where the ceramic ensemble flourished. I was joined by many eminent musicians performing and recording tapes, CDs, musical soundtracks and dance scores; members included Chris Darrow, Rico Garcia, Ben Harper, Ernesto Salcedo, Heartt Stearns, Norma Tanega and others.

I have a long history of exhibiting ceramic instruments and sounding sculptures. While living in Los Angeles, I became affiliated with the Couturier Gallery where I have had many exhibitions, including a series of sculptures which I started making in the early 1990s, *The Deities of Sound*. They first appeared in a series of dreams as images of beings whose existence was otherworldly, whose voices were full of knowledge, whose origins were beyond the earthly plane. To date, these works are some of my most tenuous. In their making, I have had to suspend judgement. They are made at the insistence of my subconscious and are meant to be a testament of what I have learned in their making.

I am currently living in St. Petersburg, Florida, where I accepted a teaching position at Eckerd College. My latest musical project is the worldbeat ensemble "Common Ground" a collaboration with my colleague Joan Epstein and many talented students. I anticipate creating many future musical inventions and projects and thank Bart Hopkin most heartily for his including me in the final publication of *Experimental Musical Instruments*.

Above: Triformation VIII. Whistling water vessel

Below: Triformation IX. Whistling water vessel

Brian Ransom, currently an assitstant professor of visual art at Eckerd College in St. Petersburg, Florida, is a sculptor, potter, composer and musician. He has made numerous recordings of original music. He has been a Fulbright Scholar in Peru and and NEA fellow in sculpture. His work has been included in exhibitions, collections and museums throughout the United States. Brian can be reached by email at ransombc@eckerd.edu.

(More photos on following pages) →

Left:
Ceramic Harp
(Kora)

Right:
Double nest of
Pot Flutes

Left:
Automatic
Ceramic
Resonator III

Right:
Automated
Whistling
Pads
(electric
wind
instrument)

Left:
Dieties of
Sound I,
"Singing Diety"

Right:
Dieties of
Sound XVI,
"Defining"

Left:
Dieties of
Sound XIII,
"Ponderance"

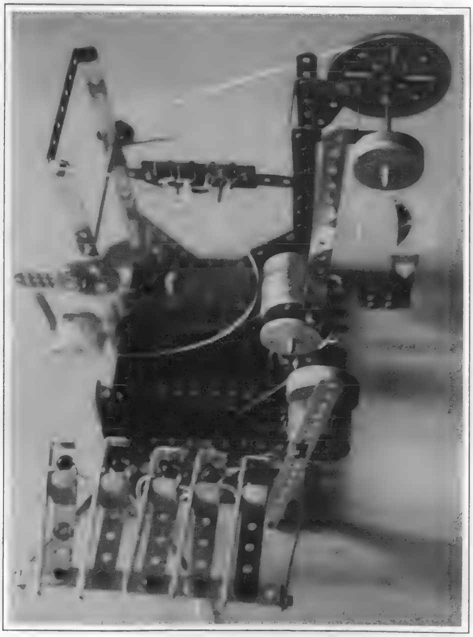
Right:
Dieties of
Sound XIV,
"Traveler"

THE PHOTOSONIC DISK

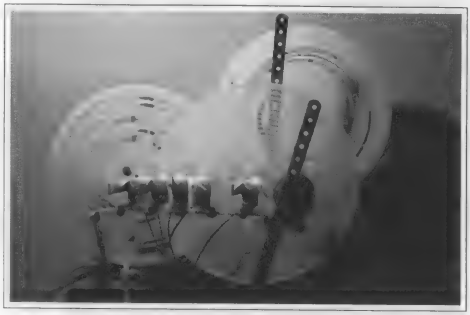
by Jacques Dudon

A BRIEF HISTORY

In 1972, looking at the ceiling fan at my singing teacher's home in Benares[1], I happened to have a strange idea: "what would happen if I fixed a ring on the blades, pierced with holes, in order to pulse the light sent to a photoelectric cell behind it, and plugged into the stereo?" Surely, I thought, if I could manage to space the holes at different regular intervals chosen to produce the right chords, that machine could be used as a tambura — that is, as an instrument for drone accompaniment. Then, I asked some friend to send me a photoelectric cell, which never came, and this is why this "optical tambura" never saw the light before I came back to France. It wasn't until 12 years later, on the 22nd of February 1984, that I was able to experience the idea. What did I do during twelve years? Collect butterflies? No, I simply made other kinds of instruments, playing with water — but that's another story.[2]



1: Lumiphone (1984)



2: Lumiphone with cardboard disks

So, on this particular day in February 1984, I was thinking about making an instrument that would be able to sing vowels — and then came this idea again — but this time I had a photocell. I rapidly cut some holes in a small cardboard disk attached to a tiny DC motor … which instantly sang a few notes with a melodious, harmonica-like sound. Oh, the happiness that awakes with simple things!

Actually it didn't work at once in imitating the human voice, but on the other hand, after sketching a few disks, I was able to produce quite a good recreation of the sound of an Indian tambura. Anyway, from that day my interest went more towards creating a completely experimental instrument, and this is how it turned out to be. At first it took the shape of a platform, rapidly assembled with "Meccano" ("Erector Set") parts, able to receive interchangeable disks, up to four at a time, turning at various speeds. I called it the lumiphone (photo #1, with the same machine seen in action with its cardboard disks in photo #2).

After creating different versions of it and enjoying it more and more, I went to the patent office, proud of my discovery. I found there that electro-optical instruments had been already invented, probably since the use of optical soundtracks in the movie industry. But no conflicting claim was found by the patent research office with any of those previous instruments, I guess all of them being of the keyboard harmonium type, while my project was describing freely moving control elements (light sources, optic filters, sensors) with a vast array of interchangeable disks. As our organization applied for a grant to continue its researches, I was asked to register a patent, and this is what I did, not in the form of one precise instrument, but as a "new process for sound creation" — leaving it open to further evolution.

3: Cutting cardboard disks

My intuition was right, because the instrument, following the progress I made in its gestural controls and in my compositional ideas, never stopped evolving. From a complex apparatus at the beginning, to rather discrete systems today, passing occasionally through various particular applications (playing with the sun, playing automatically, etc.), it became more and more centered around the disk itself. Thus the instrument as a whole, now named the "photosonic disk,"[3] gradually became identified with the central vibration-causing element.

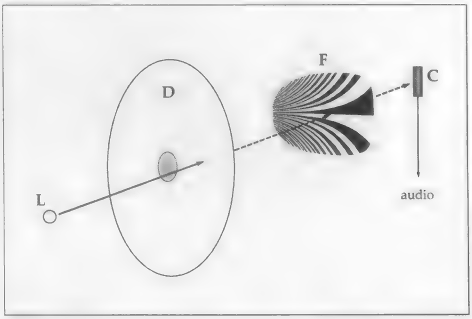
After my successful experiment of February '84 with a disk of two inches in diameter, I wanted to explore all kinds of disk patterns, and what they sounded like. It was an absolute thrill, and still is today, to be able to hear sounds that you design visually. To understand better what was happening in the process, I needed to test as many disks as I wanted as fast as I could. My first ideas were cut with a knife in the most common A4 cardboard sheets available (21 cm wide). Up to now this is still my most standard diameter. Photo #3 shows myself manually cutting this type of cardboard disk. A hundred of those were made between '84 and '86, and served for many concerts in Europe.

In 1986, Daniel Arfib, computer music researcher in Marseille, and I began to design a software program for using a plotter to draw our disks in india ink on tracing paper. For every 40 disks plotted, I spent one full night developing negative films from them through photochemical processes. They were then left to dry, later to be cut in the shape of the final disks. With the patterns now appearing as opaque areas on a disk of otherwise transparent film, the cutting of holes was no longer necessary — the light would be blocked in the opaque areas while simply shining through the transparent areas as the disk rotated. Between 1986 and 1990, 400 different disks were designed this way — among them we find all the disks played in my CD *Lumières audibles*[4]. This ink technique allowed neither grayscales nor very fine lines, but still allowed many different waveforms in all types of scales. In 1990 however, after several repairs, our plotter became irremediably out of order, and that was the photosonic disks' momentaneous end. Recently, however, Patrick Sanchez, another computer researcher from Marseille, started to transpose Daniel Arfib's software into PostScript[5] language. We are still working on that tool today. It will allow in the coming years a real renaissance of the photosonic disks, with a quality level never attained so far. Among other improvements, besides a much finer precision and access to the best of electronic printing systems, this third generation includes grayscale possibilities and new graphic operations.

THE PHOTOSONIC PROCESS

How does a photosonic disk produce sounds? We know light is able to transmit signals of audible frequencies. This is how sound recorded on the tracks of the ancient "optical sound" movies is made audible (this is also how astronomists receive some of their information from the outer space, such as pulsar's revolutions, etc…). In the photosonic process sound is generated in a similar way, by communicating audible frequency modulations to light beams, having them pass through a rotating disk which is alternately opaque or transparent. These pulsated light beams are received by a photoelectric sensor, which transforms their variations of luminosity into variations of electric current, directly amplified by an ordinary audio amplifier connected to a speaker.

The figure below retraces the path of the light, from the light source (L) to the photocell (C), passing by the disk (D) and an optic filter (F):



The photosonic disk then works very much like a siren[6] that uses light instead of air pressure, except that photosonic instruments are necessarily electric, needing amplification and speakers. On the other hand, while pressured air rapidly diffuses and looses its energy in open space, light does not, allowing all the elements used in the photosonic process (light sources, filters, sequencers or other additionnal disks, even sometimes the photocell itself) to be moved freely in the three dimensions, offering many sound controls with a maximum of precision.

Again, seeing that so many people have not believed it, it should be emphasized that these instruments are not connected to any kind of sampler or synthesizer that would make them sound. They proceed by a purely optical generation of sound, and are simply amplified by electric means. But each photosonic disk can itself be seen as kind of a synthesizer program, where imaginary sounds are condensed in a graphic form.

Knowing this, you may ask: what are the sounds you can produce by this process?

Here we have to start from the vibration-inducing element,

the disk in itself, and to consider three different aspects always present in any disk:

1) the waveforms used, that will determine some of the spectral qualities (the timbral dimension) of the sounds;

2) the number of repetitions applied to these waveforms, that will determine the musical scale of a disk;

3) the way different sounds are spread on the surface of a disk.

As we shall see, these three aspects are often strongly related to each other.

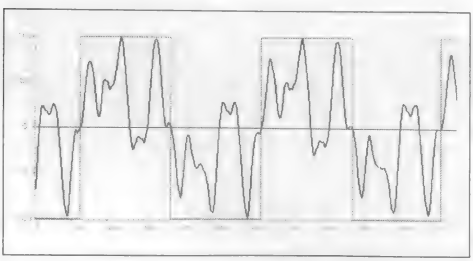
WAVEFORM GEOMETRY

Types of waveforms I experienced in my disks are of a considerable number, and their description would exceed the length of this presentation. They range from "single hole" waves to fractal patterns that auto-develop themselves from geometric laws of progression, as well as waveforms designed to resynthesize external acoustical sources.

Only waveforms using two zones, like white and black (or in case of sirens, one hole per period), can be simply modeled. Those are determined by their cyclic ratio, that expresses the length of the opening (or the transparent section in disks printed on films) over the total wave length. There is an acoustic law associated with those waves, which says that it shows a lack in its harmonics close to the inverse value of the cyclic ratio, or multiples by 2, 3, 4, etc. of this inverse value. For example, a "square wave" traced on a disk is supposed to cut harmonics 2, 4, 6, 8, 10 etc., in other words it will be richer in odd harmonics; a wave of an opening five times smaller than its length will have low overtones 5, 10, 15, etc. Waveforms using more than two zones (for example 2 holes per period, etc.), even for simple archetypes, enter at once into much more complex acoustical models, not to mention when those zones have more than two different grayscale values or worse, when they use gradients.

It is important to specify that what is drawn on a disk and what comes out of the photoelectric sensor are two very different things, making it quite impossible to predict what any given pattern is going to sound like. Fig. 5 illustrates this with the simplest waveform one can imagine: a square signal, that is alternating opacity and transparency in equal proportions. Superimposed over it in the figure is the waveform of the actual sound generated, which has very little in common, as you may notice, with the original pattern.

Furthermore, a disk never plays the same sounds either, because its sounds totally depend on the way it is played. Speed, radius, light disk distances, and the presence or absence of optical filters will dramatically shape the output timbre.



5: Electrical response to a simple waveform

TUNINGS

Portions of this section may serve as a complement to Bart Hopkin's appendix in his very well documented article on sirens[6].

In contrast to timbre, a disk's scale is totally predictable, the frequencies of the fundamental tones obtained being strictly proportional to the numbers of repetitions of the periodical waveforms printed on the disk. By simplification, I usually call these numbers of repetitions the "frequencies" of the disk (the frequencies heard are actually the product of these numbers and the rotation speed of the disk, in revolutions per second). For someone familiar with just intonation, intervals generated by a disk are easy to understand: their ratios are the same as the repetition numbers' ratios. Usually these are whole numbers, to avoid a noise created by an irregularity arising at every cycle of the disk, and this is why disks are perfectly suited for just intonation.

In pure theory, a disk can only produce overtones of its own speed rotation; but considering what we hear this is not so true.

Bart Hopkin mentions an early disk of mine bearing fractional repetition numbers. I made indeed such an experiment once, to hear how it would sound. I found three cases where this solution is of interest. The first case is when the disk turns so fast that the fundamental produced by the fractional irregularity passing once with each rotation becomes audible as a bass drone. The second is when you use this disk with an "optical sequencer" or in a photosonic Barbarie organ (described later): if the notes are short enough, you may not notice the noises. The third possibility is to use those disks as optical sequencers themselves, where they may serve specific rhythmic purposes.

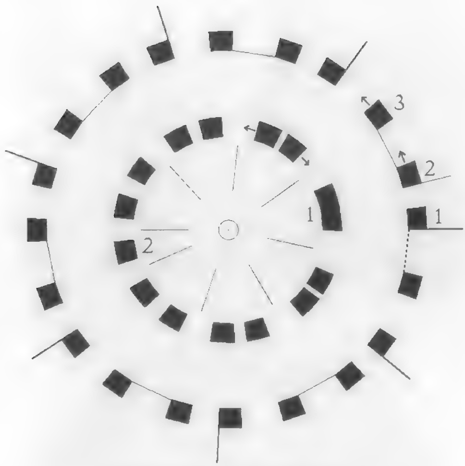
About this question of fractional frequencies, later on I found different techniques, based on cyclic timbral modulations, that make non-whole numbers acceptable. This can be useful because if it can be done in only one ring in a disk, it can help divide by two the total number of waveforms on the disk. In the case of a siren, this can save lots of drilling.

Fig. 6's inner ring shows such a technique I call "grillon" (the cricket): between 1 and 2, the original line of the waveform splits in two, changing gradually into the octave waveform (in 2), which allows the integration of an additional line, increasing the fundamental frequency of 0.5 (from 7 to 7.5 in the example shown).

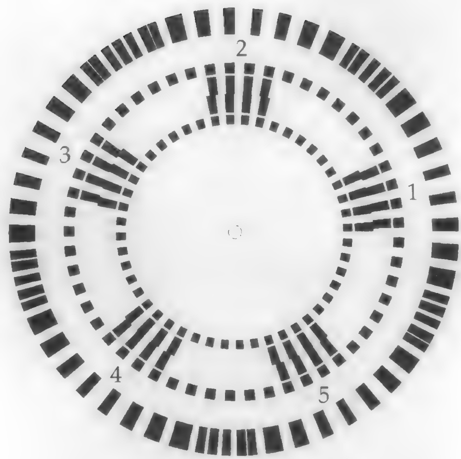
The outer ring of fig. 6 illustrates another technique I call "ours" (the bear), because of the gently groaning sound those waves usually generate: here is a wave composed of three dark lines, of which the second and the third will slightly move forward on each period in such a way that, getting closer to the first line, after one full cycle they will simulate a dephased form of the original wave, being able to join with it at a different spot (line 3 becoming line 1 here). As a result, the perceived repetition frequency is not 7 here, but 6.66.

That technique, and the grillon's, could be used to create alternative tunings; actually, I have only used them so far to produce different timbres. Apart from these special cases, I only use whole numbers — which is enough to express practically any just intonation system.

In theory, audible frequencies drawn on a disk could range between 3 and 2000; in practice, the repetitions I use range approximately between 5 to 500, which covers almost seven octaves. Rather than being a limitation, although it forbids the use of tempered scales, I have found the rule of having tone frequencies proportional to whole numbers to be quite broad. By



6: Fractionary frequencies: grillon & ours



7: Composed frequencies & intermodulation

chance, it's also particularly instructive concerning the harmony of musical scales.

FROM CHORDS TO TIMBRES

There are many ways to mix sounds on a disk, from pure additive synthesis to various graphic combinations that will result in the synthesis of totally new waveforms. Chords can also be created of course by playing with several lights. Different vibrato movements given to each light will then make the chord sound more like a polyphony, instead of a single composite sound.

The simplest way to produce chords on the same area of a single disk consists of printing small rings of different frequencies close to each other. The sensor that reads a certain portion of the surface of the disk then makes the sum of the frequencies of each ring. It is even possible in this manner to organize small sound spectrums.

Another way is what I call an "omission": by creating a periodical accident on a waveform; omitting one line out of every *n* lines, etc. If then *F* was the original tone frequency, we add to it a bass tone of frequency *F/n* (this can be seen in disks E & F on page 41). *n* has to divide F a whole number of times, otherwise a noise of frequency 1 will be heard.

If not, the technique of omission can be applied to what I call "composed frequencies", of which fig. 7 second and third rings show two examples: just next to a frequency 48 (first ring from the center), the 2nd ring shows 5 groups of four lines each, while right next to it, the 3rd ring selects 5 similar groups out of a frequency 53 (4th ring).

Five is neither a divisor of 48 nor 53, but selection has been made in the best balanced way to give the illusion of a regular frequency 5 in both cases. The result sounds nevertheless as a bass drone (frequency 5) with "inharmonics" 48 & 53, in a sound comparable to oboe or bassoon multiphonics. "Composed frequency" disks can also be used successfully as optical sequencers (discussed later with the instruments).

The outer ring of fig. 7 shows one last specimen of chords I call "intermodulations", generated by graphic superimposition of waveforms. We notice that on 5 spots (1 2 3 4 5) the two frequencies (48 and 53 here again) are in phase, causing an increase of transparency, while in between, phase opposition darkens the resulting waveform. But the result, rather than being a simple sum of the two waveforms, is a complex signal which contains strong difference tones, such as a clearly audible frequency 5 here, the difference between 53 and 48.

Depending on the harmonies between the original frequencies, these intermodulations may sound from compact harmonic tones to dissonant or metallic "inharmonic" timbres. Here 53, 48 and 5 are a bit low, but with higher frequencies we are able to see the resultant difference tones through visible "moiré" effects (disks H & M on pages 41 and 46.

There are many ways I found to create intermodulations of various timbres, which is one of the interests of that type of chords, out of black & white waves, and even more with gray level waves, by integrating gray level values in the additive operations.

And, finally, having the same light beams passing through two or more successive disks will also create intermodulations, generating strong difference tones with powerful phasing effects.

COMPOSING A DISK

When composing a disk, bass tones usually start from the center, and higher ones spread to the periphery, but everything is possible, such as special orders, arpeggios, glissandi, gradual blending of rings, etc.

A disk is basically the disposition, within the proper usable radius (between 16 and 100 mm in my usual format), of specific waveforms, repeated at specific frequencies. In complement, certain dephasing is often arranged by rotation in between rings in order to smooth transitions and to optimize chord timbres, if

not for purely visual esthetic considerations.

So, what kind of music can be drawn inside a circular image of 20 cm in diameter? Just about anything. A disk has to be thought of as a painter's palette; one who often mixes adjacent colors to create special shades. Many disks I have done use only one type of timbre, but some of them gather as many as possible. Same with intonations: some disks play one single drone developed in various textures, while others simply develop a scale, or eventually do not present a single stable tone at all.

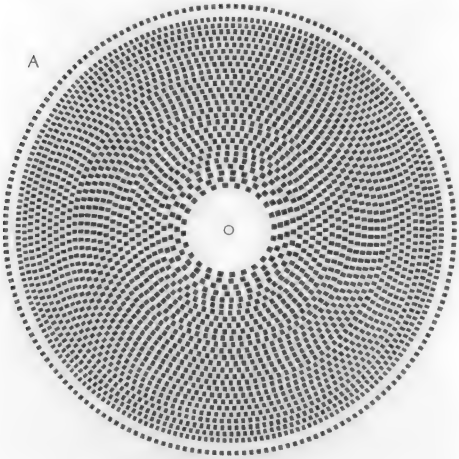
With the years, I tend to make disks in which timbres and intonations are more and more strongly interwoven, with several listening levels (tones, undertones, overtones, inharmonics, noises) and gradual spectral developments, rather than purely linear melodic scales or transpositions of one single timbre.

A SELECTION OF DISKS (1984 - 1990)

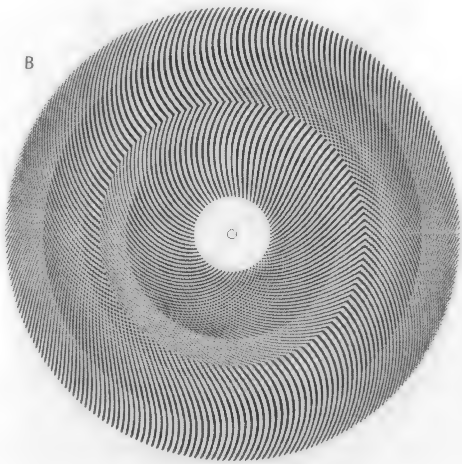
The introduction explains why this selection stops in 1990. This is not a selection of the most spectacular disks I made, but only complementary examples chosen to explain how patterns have been conceived to achieve specific sounding results.

A shows the simplest waveform available — equal alternation of black and white at frequencies chosen to reproduce the traditional chromatic scale of a "27-keys Erman" Barbarie organ (mechanical organ very popular in Europe, using perforated cardboards). Very often, in my photosonic Barbarie organ (described later), I have replaced this disk with a similar disk tuned to a javanese slendro scale, while playing the cardboard of a Mozart piece — to give it a change.

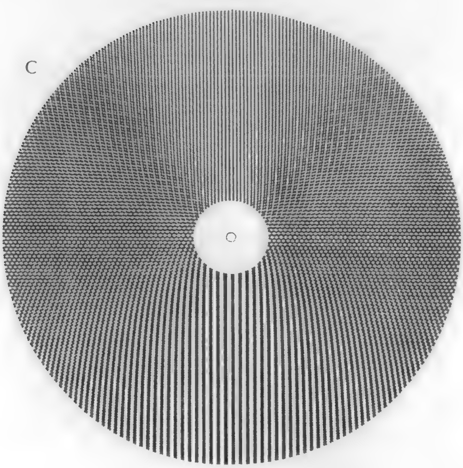
A



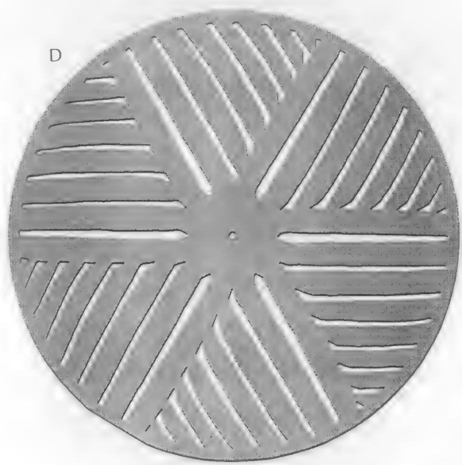
B



C



D



B shows the same simple waveform, producing some kind of a flute tone, applied to a "glissando", for the same instrument. This is realized by increasing the frequency of every new ring by one unit (2 units in the second octave) on very thin rings.

Each radius has been calculated to follow a logarithmic progression. That means that whatever the transposition of a chord, it will be represented on the cardboard by equal distances in width between holes.

C. This is another glissando performed in the "grillon" type of waveform (see Fig. 6). This one was not meant for melodies, nor tuning facilities, but just the interest of the timbre. It's often been used in the "Balai-magique" automated instrument (photo #10).

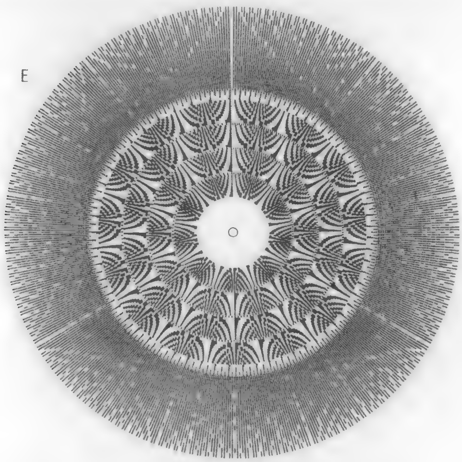
D. One of the early cardboard disks. As the shape of the openings suggests, this is a "comb filter"— the more you get away from the center, the higher are the overtones you hear, based on the fundamental tone of this disk, of frequency 6.

E. A "double" disk, meant to be played with two lights. In its center are four tones (at frequencies of 9 - 10 - 12 - 15) and their developed spectrum (using the technique of the comb filter as in *D*). Toward the outer edge is a pattern using the "omission" technique from a fixed frequency of 540 in all its available dividers, generating a sub-harmonic series.

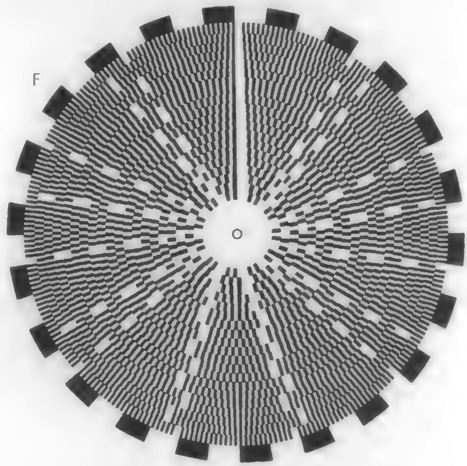
F. The omission technique again, on the tones of a "mohajira"[8] scale. The "omitted" frequencies, 9 and 11, are well visible here in the shape of a star. I used this disk in "Sumer"[6], where obviously my needs were of those two bass tones only.

G. With cardboard disks, having to cut openings manually, I was

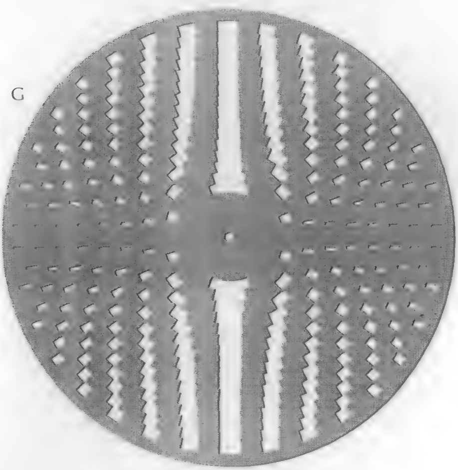
E



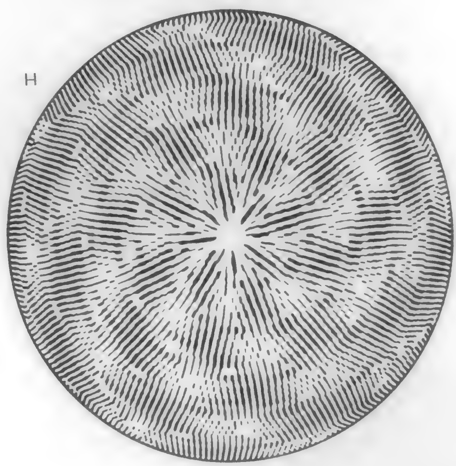
F



G



H



also using high rotation speeds in order to reduce the number of waveform repetitions within each ring. Here is one of those disks, based on a spectral development (the first sixteen harmonic overtones intermodulating two by two) of a single fundamental tone of frequency 2, which means that it could be audible as a bass sound only if the motor's speed was higher than 12 revolutions per second approximately. At that speed the disk would create a wind which I allowed to blow randomly on the flame of a candle, used as light source.

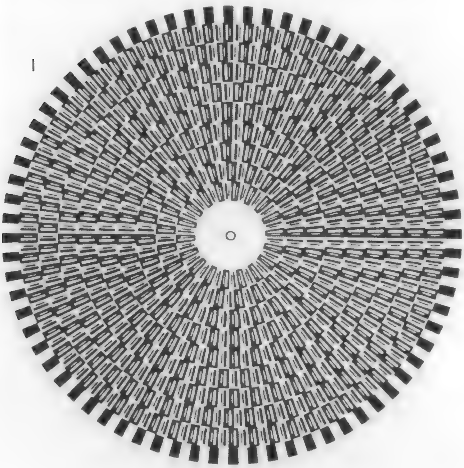
H. This disk, used in "Fleurs de lumière"[4] shows another example of intermodulation, between Fibonacci and other golden series of numbers. This special tuning in interaction with precise phase relationships between consecutive rings creates interesting alignments, and ultimately, the scale becomes a timbre texture.

I. A fractal waveform of a type I call "Clar" because of its clarinet sound, in its first developments only (3 and 5 lines per period). The scale is a slendro issued from the Fibonacci numbers 3 - 8 - 21 - 55 -144, very close to one of Lou Harrison's favorite slendro scales.

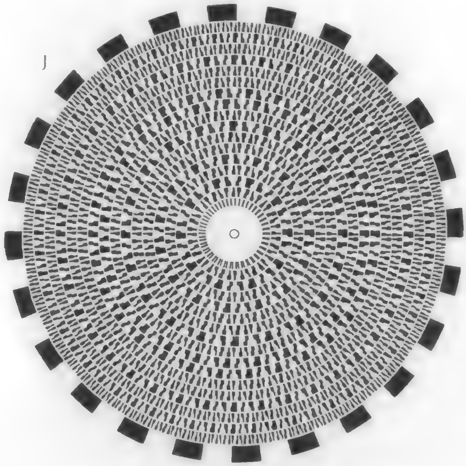
J. Diatonic scale geometrically "linking" the fractal waveform of disk *I* with another one based on the number *Phi* (1.618). Both are chosen to have their major overtones (3 and 5) coherent with the scale.

K. A sequencer disk, based on a modelization of the heart of the sunflower. The triangular shape of the openings are meant to produce a percussive envelope on each note. This polyrhythmic sequence, based on Fibonacci numbers, can be heard in the beginning of track 2 ("Tournesols") of my CD. If used as a tonal disk, this disk also generates the fractal waveform *Phi*, used

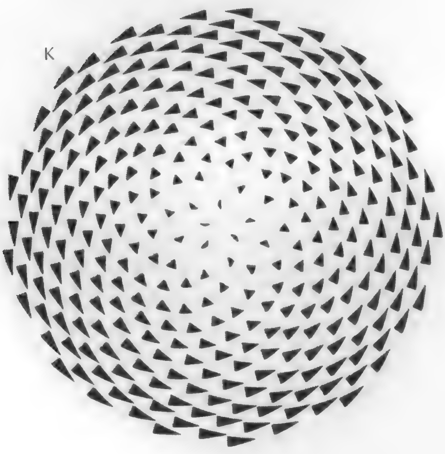
I



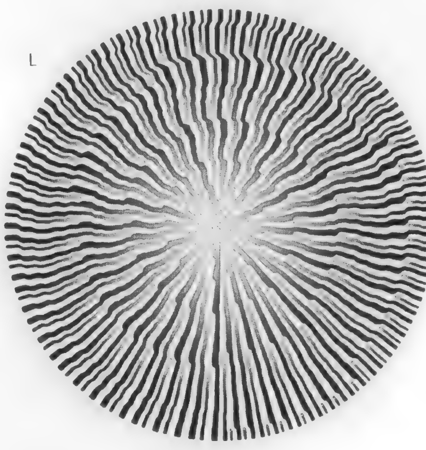
J



K



L



intensively in the same piece.

L. The same fractal *Phi* waveform again, but modulated in a glissando transposition of a 1.618 ratio over one full revolution. With each spiral revolution, the wave gradually changes into its precedent fractal unfoldment, and the result is a continuously increasing sound (or decreasing, depending on the direction of rotation) that has yet no audible beginning. If the disk turns rapidly enough, we hear a kind of a "pink noise" bubbling. I have used this disk successfully with a light itself rapidly turning at various speeds, causing long cycles of pitches determined by speed differences between the disk and the light motors. It is a nice "inharmonic" alternative to my usual FM disks, whose frequency descends one octave per revolution, while splitting gradually towards a 2nd harmonic in the "grillon" way (Fig. 6).

SOME OF THE INSTRUMENTS

How do you play a disk, and what are the controls you may use to transform the sounds you play? The photosonic process provides many types of gestural controls, which I will review here for each instrument.

With my first prototype, called the "lumiphone" (photos 1 & 2), I was already experimenting with most of the main features of the photosonic controls today, such as mobile lights, optic filtering, and a sequencer. The light sources of the lumiphone were on the right side of the main disk, small lamps manually held, powered by 6v DC, or even candles. The absence of mechanical inertia in these mobile lights is something unbelievable, if you never experienced it. By gliding from left to right you run through the scale, making chords if you use several lights, while moving lights vertically you add vibrato or phasing effects, and by changing the distance to the disk you can control intensity but also resonance. With a candle, the sound is more diffuse and has a pleasant flickering musical quality.

8: Sirius (1985)

9: Tablette à percussions (1985)

On the left side an array of five small lamps that could be progressively masked played with the "optic sequencer", a slow-turning opaque disk with holes designed to allow light from the main disk through according to specific rhythmic patterns. A ventilator used to spin a lamp connected to a battery box completed the light sources options.

When the right hand is not used to hold a light, it usually holds an "optic filter" of some sort, the simpler one being a transparent film with more or less contracted stripes (photo #11); some others use optical convergent elements. This tool selects harmonics from the disk's projected shadow on its surface, that are in concordance with its own patterns. It is used gesturally like a bow, but one that would control the timbre, attack, decay, and vibrato of the sounds.

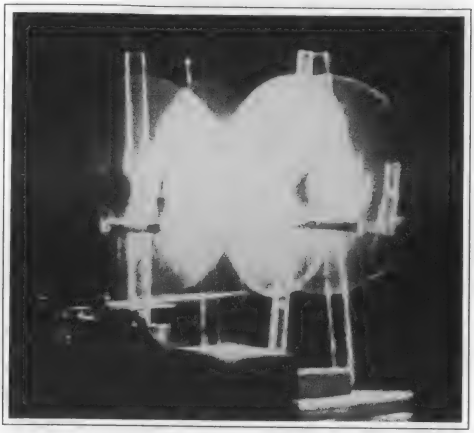
The main disks could be single or double, concentric or not, which would allow different intermodulations. In front of the photoelectric cell a special disk was used, providing an interesting stereo phase shift between two photovoltaïc silicum cells, directly plugged in the channels L & R of an ordinary stereo amplifier. Later on, I found that microphone impedance transformers could help prevent speakers from burning out, an accident which happened to me many times at the beginning, the direct current sometimes delivered by the cells being not well accepted by normal speakers.

Double interception was performed another way in the instrument called "Sirius" (photo #8), playing with all the possible ring intersections between two disks permanently turning together, thereby exploring all the difference tones available between their combined frequencies.

Sirius is played either manually or with the help of a small keyboard. An automated system also allowed it to play loops of fast twinkling sequences that were determined by the placement of the removable lights inside a perforated plate of plexiglas. This was very Christmassy-looking.

In the "tablette à percussions" (photo #9), a simple but pleasant toy-like instrument, an opaque screen hides the lights until they touch a soft piece of felt, colored with lines for each corresponding tone. This lets you play percussive or organ sounds, while anticipating pitches and controlling intensity.

"Balai-magique"(photo #10) is the first automated photosonic prototype I made: it uses one single light motorized between four



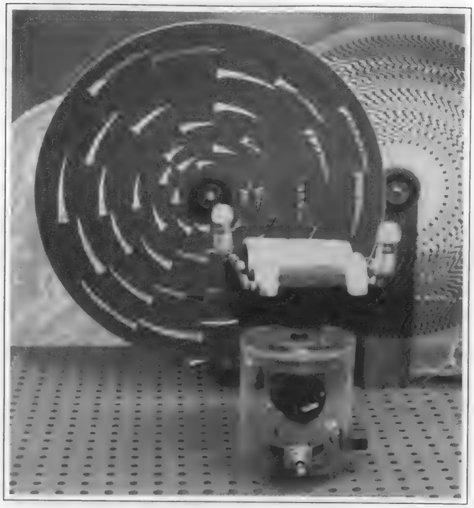
10: Balai-Magique (1985)

disks. Its evolution is programmed with the help of two levers pulling it in two directions at a right angle. Because of the chosen speed of both levers, the trajectory of the light follows specific Lissajous figures that produce an interesting interpretation between the four discs.

"Photon" is still today the instrument I use the most in my concerts. It is basically a compact "lumiphone" with an integrated electric power source inside the same box that holds together the motor and the cell (photo #11), and the option of assemblage between different modules on the same socket.

Photon's sequencer, one of these modules, is of a new kind, using large horizontal cells capturing one full radius of the whole disk's shadow. While in the lumiphone the distance between the lights and the sequencer disk did not vary, photon allows it to vary, bringing lots of additional interpretations. In photo #12, photon is seen used with such a sequencer (left side of the main disk), and a rotating light sweeper.

11: Photon (1986)



12: Photon's optical sequencer and rotating sweeper

Photon also allows the use of tonal disks on both sides (left and right) of the optical sequencer, in order to pulse associated rhythmic patterns coming from the same sequencer disk simultaneously into different scales and timbres.

Sequencer disks are still cut manually today from cardboard sheets, by first drawing a certain number of radii corresponding to the desired cycle, then by cutting holes at different places to create rhythmic patterns. By cutting "triangular" holes (photo #12), we create a decay in the sound's envelope, such as plucked strings or percussions. Many other kinds of patterns, rhythmic or not, can be applied. Certain tonal disks, or their superimposition, also provide various polyrhythms.

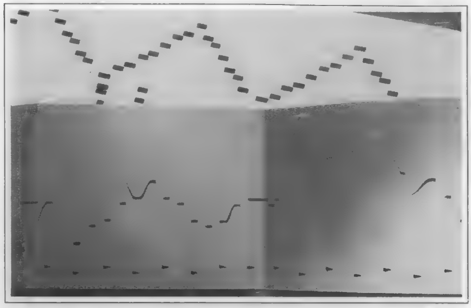
Some of the selected tonal disks (*F*, *I*, *J*) show an outer ring with a repeated square signal. This was used to tune several disks playing together, with the help of a synchronisation speed circuitry that was designed by Daniel Arfib. The frequency of that outer ring was detected by a small infrared opto-electronic fork, which would make the circuitry send more or less current to the motor depending on whether it would be lower or higher than a fixed frequency chosen among a set of dividing frequencies provided by a quartz oscillator.

Another feature of photon is the possibility of laying a piece of paper under the light's stand, on which you can draw a map, taking the form of converging lines, to serves as a visual guide representing different light positions for the disk you are playing and other information. With the "tablette à percussions" this is the only system allowing you to play the tones you decide on before the sound starts.

The "photosonic Barbarie organ" (photo #13) uses a technique similar to the sequencer disk, in order to read the 130 mm-wide perforated cardboards used with traditional Barbarie organs.

The tonal disk (such as the disks *A* or *B*) is removable from inside the box (photo #14), and can be replaced to change scales or timbres. Among other features, this photosonic version of the

13: Photosonic Barbarie organ (1987)



15: Perforated cardboards for photosonic Barbarie organ

Barbarie organ can freeze on one chord, or read in reverse, as the crank is used here only to move the cardboard, and not to operate the bellows as with the traditional Barbarie organ.

Photo #15 shows different styles of cardboards played by this instrument. The one above is in the traditional "27-keys Erman" format (one of the standard formats provided with thousands of songs, classical and jazz pieces in Europe). Below is one of my own carboards[7] integrating intensity control, dynamic envelopes and glissandi, not permitted in the normal Barbarie organs.

"Aton" (photo #16) is, to this day, the only photosonic instrument using the sun as a light source.

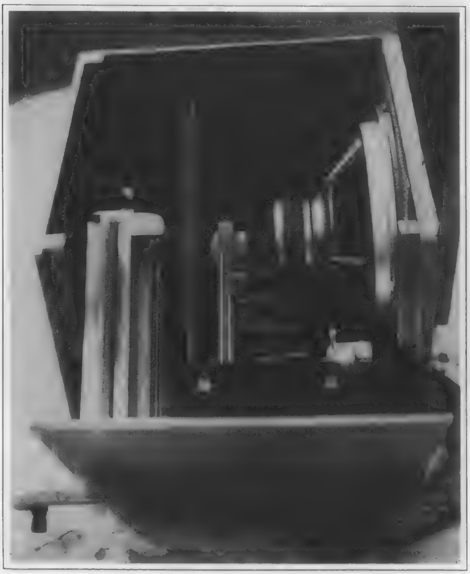
To be played outdoors, its disk is kept inside a transparent box, that protects it from the wind. As you know the sun can't be moved, it's up to the player to move the solar cell instead. He stands therefore behind the disk, and his eyes are exposed to the pulsated beams, which can be totally hypnotic.

Playing Aton allows very different techniques, such as changing the solar cell orientation, or using the fingers as a filter and to play rhythmic patterns. Because the sun's rays are almost parallel, the size of the disk's shadow is not amplified as in other instruments, and large disks (30 cm here) are more comfortable. I also dream of making giant disks to be used in sunlight installations.

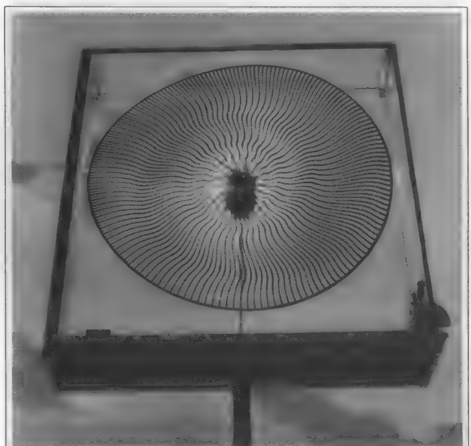
In the early morning or the end of the afternoon (when the sun is low in the sky), Aton can be played directly in front of the sun, but using a mirror allows it to be played at anytime of the day.

The "D.R.I.C." (double rotofiltre à interprétation coronale) was designed for interactive installations, with a new type of optic filtering produced by two "rotofilter disks" concentric to the main disk (photo #17), radically transforming its initial sound.

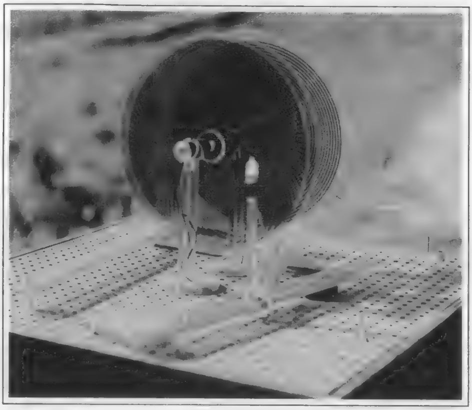
These rotofilters are high-frequency modulation disks slowly



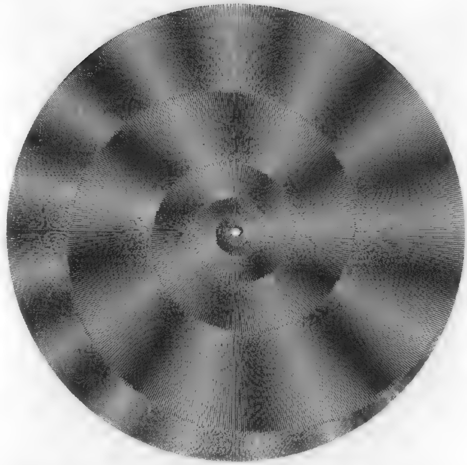
14: Photosonic Barbarie organ (inside)



16: Aton (1990)



17: Double rotofiltre à interprétation coronale. (1997)



turning at slightly different speeds, in order to create changing moiré patterns, that filter but also transpose the sounds with continuous modulations. Fig. M simulates the intermodulation of the rotofilters near to their phase, as it can be seen at a certain moment of the full cycle.

In addition, the light and the photocell are moving according to specific trajectories, developing the spectral dimension of the timbres by a permanent sweep of the resonance.

With the help of a remote control, the public turns the light on with a time-switch, plays with the rotofilters and changes the read radius of the disks, making the instrument interpret other sounds.

The music of the D.R.I.C. depends to some extent on the tonal disk played, but it can be generally described as aleatoric gliding voices with surprising overtone melodies, with bass murmurs and whispers. It can never play the same thing twice, even without the public's help.

NEXT PROJECTS

One of our main actual projects is to work on sound resynthesis through photosonic disks. We have just succeeded in the transcription of several vowels, and this will enable some of our next disks to sing in a manner close a human voice, the object I had in mind when this adventure started. We are also working on graphically blending sound with more and more precision, to approach cross-synthesis effects. Our aim is now to be able to produce ever more creative disks, in a wider range of timbres and with the highest printing quality. With the help of progress in the field of computer graphics, and the research we've been doing during these last fifteen years, we feel that optical sound generation comes today to a new actuality, with lots of potentialities still unexplored. Though we have created nearly 600 different disks, we realize that we are only at the very beginning of our experimentation with light as a sounding material.

But this allows us to consider the time to be ripe for the next step, which should be the commercialization of the photosonic disk — probably by ourselves, since no serious proposition has come to us up to now — and that could be the best situation anyway.

The first collection of disks should be quickly released, as soon as we have the machine to print them. It might take a little longer for the full instrument. For those who want to hear some of those disks, if there are no plans for a photosonic musician to give a concert near your home, only one CD of photosonic music[4] has been recorded up to now. It can be ordered directly from us.

If you wish to play the photosonic disk yourself, and if you are patient enough, wait until the first instrument, or at least till the first disks are commercialized.

If you can't wait, you may try your own experiments with a simple photocell, a motor and a light. Keep in mind that disks require a high degree of precision in order to produce good sounds, and be cautious about possible damage to your speakers in your first trials. And a little later, ask us for our first disks catalog. We will be happy to send it to all *EMI* readers.

Jacques Dudon can be reached at Atelier d'Exploration Harmonique, Les Camails - 83340 Le Thoronet, France, fax 33 4 94 73 80 25.

NOTES:

1. Sri M.R. Gautam, formerly Director of the Vocal Department of Benares Hindu University, now retired in Calcutta.

2. Related by Tom Nunn in "An encounter with Jacques Dudon" in Vol.3 #5 of *EMI* (February, 1988). See also "Jacques Dudon: Instruments of Water and Light", by Bart Hopkin, in *Gravikords, Whirlies & Pyrophones*, Ellipsis Arts, New York, 1996.

3. The term "photosonic disk" has therefore two meanings: the full instrument, and one part of that instrument. In French we also call the machine alone (without the disk) a "lecteur" which means "reader" or "drive".

4. The CD *Lumières audibles* can be ordered for $20 (including mailing) from the author: J. Dudon, A.E.H., Les Camails - 83340 Le Thoronet -France.

5. Digital standard designed by Adobe, used in high-quality image printing.

6. To know more about sirens, read Bart Hopkin's article in *EMI* vol. 12 #4 & vol. 13 #1 (June & Sept. 1997).

7. "Air Tibétain", "Intervalles linéaires", "Petit air de flûte harmonique roumaine", etc. (mechanical music): perforated cardboards for photosonic Barbarie organ, 1988.

THE CULTIVATED SCULPTAURAL

By Ela Lamblin

I have a few basic needs in life — to make music and to eat. To this end I created the carrot flute, which can fill both needs at once. The sound of a bored-out carrot is surprisingly clear and piercing, but it is usually short-lived due to my over-zealous appetite, which interrupts the song with a crunch. With each bite, the pitch rises, and the appetite decreases. Though the carrot flute is tasty in tone, it hardly constitutes a balanced diet. Potato panpipes and apple ocarinas help, but it was bullhorn kelp, a rope-like seaweed with a bulbous end, that gave me the nutrients I truly needed. Seaweed has more minerals than any other plant — and more musical uses, too!

The first kelp flute I tasted was an endblown shakuhachi-style morsel prepared by punching holes in the sun-baked seaweed with a rock I found on the beach near the kelp. Since then, I have made several hundred flutes, using an X-acto knife to cut the mouthpieces and a soldering iron to burn the finger holes: fipple flutes and double flutes with bake-in-the-oven clay mouthpieces, transverse flutes set with stones or crystals to plug the end, ocarinas (made from the bulb-end), and a number of different reed and horn concoctions. For the flutes, the bore taper is slight, and the mouthpiece is placed on the wider end of the kelp. For the reed and horn instruments, the conical bore of kelp is ideal because it causes the overtone series to start with the octave (instead of with the twelfth as in straight-bore reeds and horns like the clarinet). The variations of kelp instruments of this sort include bamboo-reed horns with multiple drones, Shenai reed horns with gourd flares on the end, bugles, didgeridus, and, of course, saxophones. The chromatic, deep-throated, reedy voice of my kelp sea sax (I use all ten fingers to produce this sound) is a distinctive texture in any musical soup. I have developed a unique recipe for making these organic saxophones, which I share with you as follows:

Ingredients:
- a piece of bull kelp, approximately 2½ feet long
- an X-acto knife
- a soldering iron or wood burner
- an old bicycle tube
- a bicycle pump
- a hose clamp ½"-1" in diameter

an alto sax mouthpiece (bought or made from bamboo, wood, or plastic)

To find the kelp, take a walk on the beach. The piece you want should be intact with a bulbous end and a skinny tail. It is okay if it is bent or flattened as long as it has no holes or cracks. (This next part is a trade secret; don't tell anyone.) Place the kelp in a bath of warm water until it is soft and pliable (1-3 hours). Cut the valve stem from the bicycle tube and cut off the tail of the kelp until the valve stem fits snugly inside. Secure the valve stem by clamping the hose-clamp around the kelp. Pump the kelp up with air until it is firm, and leave it in a warm place to dry for a couple of days. (Allowing the kelp to dry while it is inflated insures a perfect inner bore.) Cut the thin end of the kelp where its diameter will fit inside of your alto mouthpiece, and cut off the other end near the bulb. Tune the lowest note by cutting the kelp shorter with a knife. Make and tune the finger holes by piercing the kelp with the soldering iron and reaming out the holes. Finish with a glaze of shellac to protect against moisture and spit. (Serving suggestions: try it with conch in an ocean drum base.)

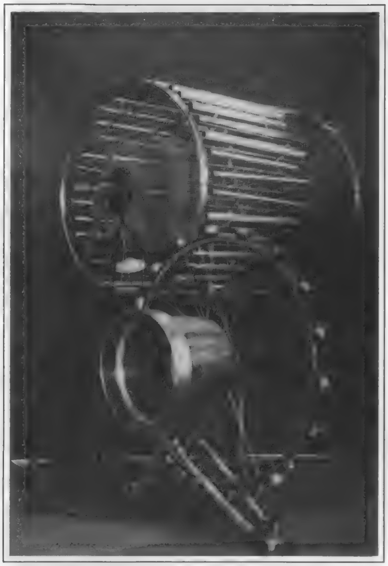
Once the basic needs are taken care of one has leisure to play and to dream. When I was a child, my favorite play was with bicycles, so it's not surprising that, when I became a man, my love of this wheeled toy attracted me to the possibilities of the wheel as a rhythm instrument on which the rhythms "play themselves" as the wheel spins around. Thus, my love of bicycles cross-pollinated with my love of creating instruments to produce a number of offspring: the bell wheel, the Rumitone, the Orbitone, and the Soundcycle, among others.

I discovered the eerie sound of bowed spokes a few years ago when I was fixing a flat on my mountain bike. (Bicycles are still my favorite toy.) When the newly inflated tube brushed against the spokes of my bicycle, the wheel played a repeating phrase. Delighted, I began experimenting with adding other sounds to the wheel, trying out all sorts of clackers and whistles until I settled on telephone bells — and the bell wheel was born.

By grinding or thinning I tuned the bells to microtonal intervals and arranged them on the rim of the wheel (which is placed horizontally). Thirty-six spokes suggested I should use polyrhythms of thirty-six. I play the bell wheel by holding a sounder (a chopstick or bow) in contact with the spinning bells with one hand, while manipulating the speed of rotation with the other. By adjusting the level of the sounder and its proximity to the wheel, I can manipulate and isolate different tones and rhythms. For example, by holding a striker so that only one of the bells hits it as the wheel spins around, a pulse is created. By holding another striker at a different location on the wheel, a counter-pulse is created which can get closer or farther from the first sound as I move the striker around the rim, creating this effect:

Ding.......dong.......ding.....dong..........ding...dong..........ding. dong.......

The ringing bells give off a distinct Doppler oscillation as they revolve. *Exciting the bells with a bow produces a cascade of oscillating overtones. A stick or clapper draws out a percussive attack and the recognizable telephone ring. The spokes are played with the same sounders as the bells and are tuned by tensioning. Once when I tightened a spoke too far, trying to get that high C, I discovered that a missing spoke created a rest in the rhythm. Also, the more out of true the rim, the more interesting and subtle the sound. The spokes always keep perfect time with the bells,



Above : Bell Wheels

Below: Rumitone

so several different sounds can be played simultaneously, all keeping the same relative rate of speed and creating a repeating phrase which is always speeding up or slowing down. Extra weight on the rim keeps the spin going for a long time, and a metal resonating dish welded to the underside of the wheel greatly increases the volume.

Having reinvented the wheel, I was seized with excitement about the possibilities of salvaged bicycle parts. I became a bicycle scrounge and a sculptor of more and more complex bicycle-based instruments. The Rumitone, for instance, is an hourglass-shaped, stainless steel resonating chamber strung with piano wire and mounted upright to a stationary bike. The performer "rides" the bike, holding a bow to the strings, which spin at varying rates of speed according to the energy applied to the pedaling. The instrument is tuned as a drone with multiple tonics and fifths with one additional dissonant note which, like a broken spoke, gives a pulse to the sound. Positioning the bow up and down the strings isolates harmonics, taking the timbre from a pleasant river-like sound in the fundamental range up to an ecstatic whirling howl of upper partials as the bicycle rider pedals furiously.

The Rumitone takes its name from Jallaladin Rumi, the thirteenth century Sufi poet who founded the Whirling Dervishes and who wrote,

> A secret turning in us
> makes the universe turn.
> Head unaware of feet,
> and feet head. Neither cares.
> They keep turning.

The secret of a wheel instrument is certainly in its turning. Rumi had it right, and he would have relished the Orbitone, which flips the player around and around, head over heels, disorienting the awareness of head and feet. Children love this sensation; they'll spin till they fall down, so it should be no surprise that the Orbitone was inspired by a toy for children.

This one was a very sophisticated toy, an "acrobatic swing" designed and built by my grandfather in the 1950s for my mom and her four siblings when they were children. It consisted of a steel triangular frame with two bearings welded to the crossbar. Extending down from these bearings were two steel bars (instead of ropes or chains) with a crossbar and foot plates where the rider stood, feet and waist strapped in, heart in throat, preparing to flip all the way up and over and around and around. (For years my aunt Sharon held the record at 300 consecutive flips before a younger brother usurped her position.) In honor of my grandfather and as a collaboration with my partner, choreographer Leah Mann, I made my own version of this swing — a musical one that is portable. Instead of bearings around the cross bar, I used an axle supported by bearings on either side of the structure. The swing part that the musician/dancer/acrobat/performer stands on is basically the same, except for a simple system of horizontal bars that hook around the ankles to hold the feet in place.

Extending from the axle opposite the swing are two fork-like bars that hold bellwheels which spin via a bicycle chain (the bicycle scrounge scores again!) attached to the structure of the swing set. As the Orbitone moves, the wheels not only spin on their axles, but also orbit around on the opposite side from the performer. The tempo of the bellwheels is always in direct correlation to the tempo of the swing. Also, as the swing moves backward, the sound plays backward.

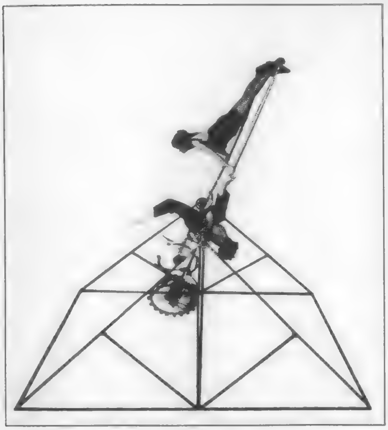
But the Orbitone is not merely a mechanical instrument, like a music box. As with all musical instruments, the quality of its music is dependent on the player. Leah persuades the swing to be graceful in its movements and specific in its shape; Leah dancing with the Orbitone is a hummingbird in the air. I, on the other hand, interact with it like a horse and rider in full gallop. Together Leah and I imbue the Orbitone with a lithe and whimsical chase-like play that has us climbing, swinging, flipping, and orbiting around the Orbitone. Again, Rumi says it best: "[They] turn as the sun and the moon turn, circling what they love."

The Orbitone as a member of the "wheel instrument" family reveals its genealogy best when it is spinning. The Soundcycle, on the other hand, is recognizable immediately as a descendant of the bicycle. Capable of creating

eleven different sounds at the same time, it has a triangular form of three independently rolling wheels, one of which, though set in the back, drives and steers the Soundcycle. (This wheel is a unicycle in a headset bearing.) An ornate spiraling steel frame; two chain-driven, independently turning bellwheels (containing thirty-six bells, six chimes and one steel string); two plectrum-plucked, revolving tined canisters; and a rainhoop steering wheel complete the contraption. Set in motion, the Soundcycle is like Apollo's chariot gone mad, as though the gold brilliance of the sun flashing against its gold-bright wheels and curling lines were setting off a wild jangle of bells struck, bowed and clanged, giving sound to the harnessing of the sun's rays for a mad dash across the sky! Riding it, Leah and I become like gods, dancing arms together like snake charmers, climbing over each other to take turns pedaling, driving our chariot in circles, turning and bending and dancing, and all the while the Soundcycle, visually dazzling in circles and spirals, loops and swirls, is aurally brilliant with a madhouse of music, an indescribable multitude of complex sounds.

Leah Mann with the Stamenphone
Photo by Ela Lamblin

So I eat, I make music, I play — and I dream. In my dream I am standing in a thickly foliated forest next to a large plant that has huge leaves radiating from a central pod, through which a strange kind of stamen twists and sways. Now I am putting a bow to this stamen and playing it like an instrument, swaying with the music. I am one with music and nature.



Above:Orbitone (Photo by Helge Pedersen)

Below: Sound Cycle (Photo byHelge Pedersen)

Out of this dream came the Stamenphone, a sixteen-string, bowed, metal sculpture. As with many of my pieces, I started with an image (a plant stamen) from which I created a form which I wanted to make musical (in this case by adding music wire). Then, having created a musical instrument, I learned from it how to play it.

Over the years, the Stamenphone has gathered integrity and complexity as an instrument, though it has remained essentially the same in form and design. Devised in concept to be suspended from the ceiling, it is constructed from two stainless steel bowls welded into an orb-like resonating chamber and set in an ornamental framework of rebar and steel rods. A crown of cast bronze leaves emphasizes the plant motif and also serves as the top bridge for the piano wire strings. For two years I played this instrument like a bowed zither, each string providing one note. Then I took a physics course in college (I had made the Stamenphone in my junior year at the Atlanta College of Art) and, studying Pythagoras' monochord and other aspects of the physics of sound, I had the idea to play the Stamenphone by touching the harmonic nodes. After restringing it with higher tension piano wire, I made a map of the nodes by painting a little dot of white on each as a visual guide for playing. This worked so well that I restrung the instrument again to maximize the range of notes that could be played consecutively and ended up with an instrument with sixteen strings and a range of five octaves. The strings are divided into four quadrants of four, each side being tuned to a different mode or scale. I change the tuning depending on the music I wish to play. The tuning gear has also been significantly improved to work with the thick strings. I started out using bolts with holes drilled in them to wind up the strings. Now I make tuning gears by

grinding a groove in the head of a bolt so that the end loop on the wire can pass around the neck of the bolt and sit in the groove. The bolt is passed through a bracket below the bridge and a nut is screwed on so that tightening the nut pulls the string tighter. I have experimented extensively with different wire gauges and now use 19 up to 25 gauge, a whole step being one gauge thinner and a half step being half a gauge thinner (25-24½). I do not use wound strings, as the winding interferes with the harmonics.

Because harmonic notes keep ringing even when the finger has left the string, the Stamenphone has a distinct, slowly decaying resonance unlike most other bowed instruments. Playing harmonics also allows multiple notes to ring out in a chord, not by playing three strings at once, but by playing one note after another and letting them fade. The strings on the side of the instrument not being played serve as sympathetic strings, adding to the resonant, long-ringing character of the instrument.

Having first dreamed the Stamenphone, then built it, then learned to play it, I next needed to develop its fully mature, musical / mystical potential, and for that I turned to the trancelike beauty of classical Indian music, in which sighing notes and sustaining tones are intricately woven in a fabric of drones. I found a teacher and learned to weave the fibers of the Stamenphone into the ancient North Indian form of music called *drupad*, making a raga rug of metallic tones. Through these lessons I discovered how to bend the pitch of the Stamenphone by pressing on the nodes. This made the instrument sigh and soar, sitar-like. Because the lower strings of the Stamenphone are also the lowest tension strings, I found I could bend an interval of a major third. Not only is this technique critical for the Indian music; it has also given the instrument the full chromatic range available in all five octaves.

And so the Stamenphone, which originated in a dream, grew up in a physics class, and found maturity in Indian ragas, induces a dreamy state in the listener, who seems to be standing in a thickly foliated forest next to a large plant with huge leaves radiating from a central pod and who, listening, becomes one with music and nature. In such a dream state, all things are possible; as Rumi says, "Reasons for holding back fly off like doves," so the three of us (the Stamenphone, Leah and I) suspend ourselves from a hanging bearing. We let go, we float, we suspend our bodies and our disbelief, our acceptance of limits, our attachment to our earthbound nature. At the still point of the turning world, T. S. Eliot says, there is no difference between the dancer and the dance, and in this case there is no difference between the dancers, the dance, the music, and the instrument. I nurtured the Stamenphone from a dream and watched it grow from steel form to instrument to music to flying dance, and like a father who learns from his child, I have become a pupil of my own creation.

If it is no surprise to those who know me that the wheel instruments have their origin in bicycles, it is also no surprise that the form of the Stamenphone comes from Nature, for if music satisfies my three basic needs — to eat, to play, and to dream — it does so only in the context of the natural world. The forms, shapes, and ornamental motifs I use are inspired by organic forms. I go out of my way to make curves instead of straight lines, and rounded edges instead of squares. Figuring out how these forms are musical and heightening this musicality through modifications, additions, and playing techniques are other steps in the creative process. In this way, function follows form. The instruments are often surprising in their tone and timbre (the surprise that such strange objects can make such evocative music is an integral part of my performance aesthetic), but their music is as organic to each as the howl to the wolf or the song of the whale to that great mammal of the deep.

Nature is inspiration for my music (and the basis for the themes of my performances); it is also the unlimited playground and crafts shop where I find both the music and the instruments. In spite of all the fancy things I've learned to do with bicycle parts and welders, my truly favorite kind of instrument is one that has grown of its own accord. Once I discovered a field of miniature seed pod rattles which I distributed to participants in a coming-of-age ritual for a boy in our family. With the subtle, delicately textural buzzing, humming, and shaking of hundreds of little seeds, we created a spontaneous atmosphere for initiation. Another time, pausing for a moment on a tiny island in Lake Lanier, I put out my hand and picked up a naturally hollowed branch flute which could be beautifully played with no alterations. Another time, on a camping trip, I located an original thumb piano, a piece of cedar that was partially split so that it had a thin tong that could be plucked with the thumb of one hand while the other hand fingered it like a string, giving melodic potential to the woody tones.

The apotheosis of these musical instruments discovered in their natural state is in my "rock" music. As with the bell wheel and the Orbitone, the origin of these rock instruments is in the play of my childhood — the sculptures, cairns, and impossibly balanced towers I was constantly building out of rocks. Now, as a professional artist, I have discovered that rocks have not only a beauty of form but an inherent music as well. On a mountain-bike adventure in the Cascades east of Seattle, I found a ridge-line vein of resonant rock that flaked off in thin sheets. When held at the node and struck, these thin bars of stone had a clear, loud musical ring. After "rocking out" beside the trail I collected a set of six pieces that approximated a pentatonic scale and toted them home. To my delight, they turned out to be easy to drill and to grind, and I quickly tuned them to concert pitch. I returned later to the ridge on foot and packed out seventy pounds of such rocks, walking the last four miles under the starlight, accompanying myself with the clinking of stone. Out of this stockpile of resonant stones I have made a one-octave, chromatic, xylophone-type instrument which is set on pieces of moss (or foam) and struck with other stones, as well as several sets of wind chimes and hanging musical mobiles.

The Sine Stones (or Sign Stones), on the other hand, were chosen for beauty and size, not for sound, and were collected from many places — creek beds in the Cascades, river banks in the Siskiyous, the coasts of Oregon and Washington. These river rocks are suspended by thin music wire from a wooden sound box hung near the ceiling and calibrated by weight (about 12-15 pounds each) by hanging several stones of different sizes together. I went through considerable trouble to drill a hole through each rock so that it could be suspended and am often asked why I didn't just wrap the rocks with wire instead, but the simple, clean line of the wire running through a hole in the rock has been worth the hours of drilling and the multiple broken drill bits.

The stones hang in an arch, or rainbow, arrangement because it is a visually striking form and because it gives the necessary gradated lengths for tuning. The instrument, which is tuned almost exclusively by the length of the wire and is played by stroking the strings with rosin-coated gloves, creating a longitudinal vibration, is set up in two distinct modes, one side of the arch being tuned to a major or minor scale and the other side to a pattern of half step, minor third, half step, minor third, etc. Having adjacent notes

Ela Lamblin plays the Sine Stones. Photo by Diana Coogle

a third apart allows me to play chords with both hands.

Because I chose stones primarily by beauty and size and arranged them by color and texture, fading them from darker greens and blues with angular shapes on one side to smooth ovals of light pinks and creams on the other side, the instrument is stunning to behold when it's not being played. But it is even more amazing in action because the rocks turn and sway as the player strokes and coaxes music from the strings. The Sine Stones require such a delicate touch and preciseness to keep the rocks from knocking together or the strings from breaking that the dance of swaying hands and stones and the exquisite tones of the music take on a deliberateness that is akin to meditation. This is not a virtuosic instrument in terms of speed, number of notes, or complexity of layout; its virtue is in its haiku-like ability to sound one note so purely and beautifully and in the corresponding visual impact of form and movement.

My desire with my work has always been to combine forms — not only food and flutes or wheels and bells but, more encompassingly, sculpture and music. All my sculptures are musical instruments, and every musical instrument I make is sculpted with attention to its visual line and form. With this interest in combining forms, is it any wonder that when I, musician and sculptor, met Leah Mann, dancer and choreographer extraordinaire, I entered a long-term collaboration with her (seven years artistic peer, spouse since May) that has profoundly influenced the direction of my work? In her I have found a wealth of knowledge of physical performance and a wellspring of ability for dance and movement that have brought a new dimension to the world of making and playing instruments. Leah has given these instruments that which all inanimate objects must yearn for: movement. She has discovered ways to transcend the difficulty of playing and manipulating a steel hoop, ball or swing. She dances with the abstract beauty of effortless movement. She has taught me how to bring the bowing or plucking of a string into the entire body so that each note is played out from hand to torso through toe.

Together Leah and I are pioneering a new genre of "musicalmovement," which might best be explained with "Balloonjarrattledrum," a dance piece that takes its name from the balloonjarrattledrum, an instrument which is made in the following manner:

Stretch a balloon over the mouth of a jar;
tighten to tune.
It's a pluckdrum.
Add beebees for shaking and rattling.
Now
Pluck it.
Rub it.
Honk it.
Shake it.
Roll it.
Tap it.
Knock it.
Break it.
Sweep it!
Make it again.

The performers in our piece do not play balloonjarrattledrums like back-up singers in a rock (the other kind of rock) band with gourd shakers. Leah and I together have composed the music of and choreographed the dance for this piece in which the movements of the players create the rhythm and the melody of the music. The five dancer/musicians knock the jars on the floor, roll them to each other, pluck them under their arms — in short, they dance, and by dancing they produce polyrhythmic and sequenced patterns of music and of movement, canons and monophonic melodies arising from the dance, as though the musical notes, like the rhythms, were inherent in the body.

In creating this new genre, Leah and I have had to struggle with the sacrifices each has to make to bring two or three disciplines together. As a dancer it is limiting to Leah to have to hold and play an instrument; as a musician, it is difficult for me to play while trying to move (gracefully and with intention). But in the evolution of this new genre, we are discovering an unexpected new vocabulary of movement and sound which comes from working within these limits. And nothing could be more exciting. It is a natural extension of the same creative process that turned carrots and seaweed as well as steel and rocks into music. It is to encounter for the millionth time the reality of experience, as Joyce said, and to forge the uncreated conscience of a new art. It is to be bold enough just to begin: "Whatever you can do, or dream you can, begin it," Goethe said. "Boldness has genius, power, and magic in it."

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BEYOND THE SHAKER

Experimental Instruments and the New Educational Initiatives

By John Bertles

Simple musical instruments have long been a staple of the elementary school classroom. Many teachers have a class unit where the students create easy instruments, such as shakers or rubber-band boxes. But student-built musical instruments can go much further than those simple old warhorses. Furthermore, the evolving state of education now presents a more positive atmosphere for instrument builders to work in the classroom. This article will explore some of the new initiatives in education and the implications for teaching artists, as well as some of the theory and practice of building instruments in the classroom — admittedly from the viewpoint of an elementary school teaching artist in the New York City area.

The author and the kids

ARTS EDUCATION IN THE LATE 90s

Arts education in the late 90s seems to be dominated by three major initiatives: The return of arts education in the schools; the new educational standards; and a cross-curricular approach to learning, with an emphasis on literacy.

The late 80s and early 90s were dark days for the arts in American education. Black Monday; the recession leading to a subsequent decimation of school budgets; and a relentless assault on the arts in America by some prominent politicians and other public figures combined to virtually eliminate the arts in many schools. Certainly the inner-city schools were the hardest hit, with many schools having no program whatsoever, but even in the most posh suburbs, classes in the arts were sustained only by parents and PTAs raising private funds to hire teaching artists and programs.

For those of us who were working to bring arts programs to schools at that time it seemed as though art was dead in America, that we were bringing up a generation of citizens who had had no experience with art in any form, or perhaps worse, an extremely superficial exposure. And yet, here in New York, the state mandates that elementary students spend 15% of their time on the "arts". How that was interpreted was up to the city, district, and school. In one school I visited I saw an auditorium full of kids watching a Disney film. A disgusted assistant principal told me that that was part of their state-mandated 15%. The school had no funds to hire teachers or visiting artists, and the inner-city neighborhood couldn't raise funds to bring in outside arts programs.

It is truly tragic, but the kids who were in elementary schools during this period will really be the 'generation without art', with all that that implies. A high school music teacher recently complained to me that although he had enough instruments to create a wind band (thanks to new funding coming in), the students who came to him had not even the slightest knowledge of the rudiments of music, such as reading music or even knowing what the notes were.

However, there are indications that things are changing.

The major impetus for change has been the booming economy of the mid to late 90s. The Wall Street-fueled boom has finally started to trickle funds down into the coffers of education departments and schools. Board of Education arts coordinators, who for years had watched arts education become the almost exclusive province of large arts institutions (who have their own agenda, after all), are suddenly finding that they have funding to hire new teachers, buy or rebuild arts supplies and materials, book programs, and otherwise revitalize their moribund curriculum.

Another reason for this change was a series of medical studies which showed a clear correlation between the arts and brain development. Most

telling were the reports that showed that children who played instruments at an early age turned out to be better at math and science. The connections between math, music and science seem self-evident, but had not previously been documented in a scientific fashion. What was discovered was that the "pathways" in the brain between the areas which are the centers of math, music and science were more developed — there were millions more neuronic connections in the brain of the child who had taken music. Studies like these began to creep through the sluggish bloodstream of the educational bureaucracies around the mid-90s.

CURRICULAR CONNECTIONS

A third force for change has been the cross-curricular initiatives (especially targeting literacy) which have finally begun to take a solid foothold in education, especially in the new Educational Standards (more about those later). When I was in school in the 60s and 70s, it seems to me that all of the subjects were taught as if there were exclusive from each other, with no connections between them, or very limited connections. For example, studies in history took no notice of climatology, and math and science seemed to be two separate realms, only distantly useful to each other.

Teaching across the curriculum and making connections to other subjects is nothing new in education. In various guises (the Whole Language concept of the late 80s is one) it has been in and out of favor for the last decade. Only in the last few years has it really begun to take hold.

For teaching artists it is a two-edged sword. Part of the devil's bargain that the arts have had to make to get themselves back into the schools is an abandonment of 'art-for-art's-sake' and an adoption of 'teach-to-the-core-curricula-through-the-arts'. For so many years as the arts were under siege its detractors accused the arts of being elitist, irrelevant to the three Rs (writing, reading, 'rithmatic), not able to contribute to the national economy, not able to help young people get jobs, etc. One result of this assault was that to get funded, the arts were forced to show that they had relevance to the core curricula of reading and writing, math, science, and cultural studies.

I'm not going to get in a discussion here of the merits of 'arts-for-art's-sake' versus 'teaching the core curricula through the arts', other than to say that there is room for both in an ideal world; but in the current funding atmosphere the latter will get funded and the former will not — almost exclusively. For the moment, anyway, it is best for those who wish to build instruments in the classrooms to make the connections (we'll take a look at some possibilities further in the article). Perhaps later, if the boom continues, we can return to teaching the arts for itself.

EDUCATIONAL STANDARDS

The new Educational Standards are also taking a cross-curricular stand, giving a boost to those of us who have been using this method for years.

Standards have been part of the educational scene for as long as there have been bureaucracies, but the last few years have seen some major changes. Educational standards try to set goals for students and teachers to reach so that efforts to overhaul education can have a unified goal rather than a scattered one. To appeal to the wide variety of cultural, economic and life-style diversity that makes up our United States, these standards have previously been rather vague, not to say foggy. In the past they were also watered-down by politics and grandstanding to the point where they were unusable.

But starting about five years ago there was a new drive to put in place a set of specific, understandable and relevant standards. In my area, these standards have been put in place in a staggered fashion. New Jersey started their new standards several years ago. New York State has the new standards on art and literacy in place this year, with math, science and cultural studies set in previous years. Even the federal government has gotten in the act, with a set of National Standards that is supposed to be coming out within the next few years (you can bet there's going to be a lot of anguished polemical hand-wringing in Congress over that one).

A lot of people — myself included — have a philosophical problem with standards in art. How can you judge the arts? It's easy enough to say that we all know bad art when we see it; but is that really a good way to judge? After all, we have our own biases, cultural and economical and political and religious etc., etc. ... But the reality of the matter is that the people who have control of the money in education are not really interested in those matters. They want to know exactly what benefit arts education will have on children so that they can sell their programs by showing the grant-givers that on this pie chart it shows that the students have a 15.7 percent increase in attention-span and a 17.7 percent increase in attendance when arts programs are in their classroom blah blah blah... Arts educators today have to swallow hard, grit their teeth and try to work within the system. One positive thing that has come out of the establishment of art standards is that there is now a solid basis for assessing arts programs — as long as the assessment is done with integrity and intelligence. One-size-fits-all assessments do not work with the arts.

One thing that the new standards seem to have is an emphasis on literacy — that is reading, writing, comprehension and logic. Even math problems have been put into word form (which is perhaps better for real-life applications). Science and cultural studies are also expected to have bearing on literacy. Finally, the arts as well must have relevance to literacy.

And here is where we get to the real meat of this article (after a rather long-winded introduction). Experimental musical instruments are ideal for making cross-curricular connections in all kinds of directions, including math and science, literacy, and cultural studies. In the next section we will examine some of those connections and how they can be made.

MAKING THE CONNECTION — EXPERIMENTAL INSTRUMENTS ACROSS THE CURRICULUM

The study of mankind is a constant and ever-expanding web, nodes of knowledge connecting not only across the globe but across time. Students can 'surf' these connections by thinking on a deeper level, moving away from superficial knowledge and searching for catalytic factors that move in widening ripples away from the source. This sounds like gobbledygook, but actually it is just a statement of a philosophical goal for curricular connections. Using these connections, students can discover not just a concrete fact, like a historical migration of a tribe, but the range of affecting factors, such as climatological causes (perhaps a drought caused the migration); cultural repercussions (what happened when the tribe moved into the territory of another — war or integration? What happened to the arts? Were they mixed to form a new synthesis?). The students should then be able to draw conclusions (how does this compare to what has happened in

history; what are the implications for us in our world?) and use those conclusions to further their understanding of the world.

Let's use an example to illustrate the process.

THE WORLD ACCORDING TO FINGER PIANOS

Say a class is going to build finger pianos with me. I build my finger pianos from a small chunk of plywood with bobby pins broken in half stapled onto the wood. Each pin is stapled in a different place, thereby producing different pitches. Depending on their ages, much of the work will be done in the classroom by the students, except the cutting of the wood and the stapling.

Already we have a science unit right there. The reason the pins are producing sound is because of vibrations. Again, depending on the age of the class, we could go right off and explore the world of sound waves and vibrations. Another natural step would be an examination of energy transfer that causes the vibrations — take it right across the electromagnetic spectrum — sound, radiation, heat, the various colors of light. The next step would be to examine why the pins make different pitches — because the length of the vibrating pin determines the pitch.

As we build the finger pianos, we have to bend the pins up to let them vibrate freely. Another effect of bending the pins is to change the pitch as we change their rigidity. In general, the more bent the pin, the higher the pitch.

So we have already determined two basic ways to change pitch: length of the vibrating object, and rigidity of or tension on the vibrating object (of course it all comes down to the speed of the wave, but we are talking about observations that we can get from the finger pianos).

The next step is to make the finger pianos louder. Rather than use the traditional method of building a sound box or resonator onto the bottom of the instrument I have the students explore the classroom as resonator. They go around the class finding out which surface makes their instrument louder. We make a list of what makes the sound a lot louder, a little louder or not at all louder. After a while we take a look at the list to see what worked best. Of course, the things that have a thin rigid surface with air adjacent to it are going to make the best sound, like the glass on the door, or a hamster tank, or a corrugated cardboard box. The best of all is a big styrofoam box.

Skip La Plante and Carina Piaggio join John Bertles on classroom-buildable wind instruments

In this experiment the students have determined the ideal way to create a resonator. From here it is possible to discover more interesting things about resonators, including why string instruments have boxes on them, or why it sounds so good to sing in the bathroom.

The next step is to look at the cultural implications of the finger piano. One way to do this is by resources. Our resources were wood and metal. People around the world build these instruments from those materials. But what if they didn't have metal? What could they use? Were these a people who had the resources around to discover how to make metal — the ore deposits, the proper fire and forge-making materials like brick and hardwood and a bellows — or did they get their metal by trade — and from whom? What were the trade routes that were followed, and how did exposure to other cultures influence them? (Think of how Hindu religion traveled to Indonesia, followed by Islam — through the sea-borne trade routes that stretched from the middle east down to India and from there down to the curve of the Indonesian archipelago).

Considering that the finger piano is extremely popular in Africa, we would next look at some of the names for the finger piano there, the kalimba, sensei, m'bira. Why are there so many different names for the same instrument? This could lead to a discussion of languages in Africa. There are thousands of languages and dialects. What does that tell us about the social structure there, and the history of Africa?

We can look at where the finger piano has gone. Some of the Caribbean countries have taken the finger piano to an extreme, especially in the rumba box — basically a gargantuan finger piano on steroids. What does the presence of finger pianos in the Caribbean mean? How and why did the finger piano travel there, and who brought it?

Math connections could be made by figuring out a way to create a non-traditional notation. For example if a finger piano has six notes:

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5544332_
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4433221_

The above is "Twinkle Twinkle Little Star" Of course, who knows what pitches will actually come out of those little pins, but the rhythm is there and so is the pitch contour. For really young kids this is a great number recognition game. For older kids it is an introduction to numerical matrices. Taking it further, using this simple notation (perhaps augmenting it with a simple rhythm system) students could create their own compositions and have them performed.

Literacy connections could also be engineered in. Each of the cultural concepts that we touched on could be the subject of a short research paper. One of the cornerstones of third and fourth grade education in New York City is the study of cultures, and this finger piano unit would be ideal to complement this portion of the curriculum.

Furthermore, the above study satisfies many of the Educational Standards. To be specific, it satisfies the following New York State Learning Standards for the Arts:

> Standard 1 — Creating, Performing and Participating in the Arts (elementary level)
>
> Music
> 1a. create short pieces consisting of sounds from a variety of traditional and nontraditional sound sources
>
> 1b. sing songs and play instruments, maintaining tone

quality, pitch, rhythm, tempo, and dynamics; perform the music expressively; and sing or play simple repeated patterns with familiar songs, rounds, partner songs and harmonizing parts

1e. identify and use, in individual and group experiences, some of the roles, processes, and actions used in performing and composing music of their own and others.

So we made quite an excursion of exploration. And it all started with building the humble finger piano. But this is just one example of the possibilities of cross-curricular connections.

MAKING CONNECTIONS — WITH INTEGRITY

For the last eleven years I have been using experimental instruments (mostly made from recycled materials) in classrooms all up and down the East Coast. I have found that just about any kind of connection can be made, as long as it is done with integrity.

Following are some possibilities that experimental instruments offer:

Environmental Studies

When I started teaching in the late 80s, there was a big drive to rebuild the moribund recycling effort. Schools used these programs as a way to raise the environmental consciousness of the children, and hopefully through them, their parents. With recycling now firmly entrenched in the northeast, the demand for this kind of program has dropped, although around Earth Day it picks up again.

A typical program using an environmental emphasis might begin with an introductory assembly program to show students some sample instruments, get across concepts in recycling and reusing, as well as basic concepts of sound, acoustics and vibration. This is followed by in-class workshops in which the students actually build simple instruments. The students are given a list of possible materials to collect, that might include (depending on the age) cardboard tubes, cans, plastic bottles, boxes, rubber bands, bobby pins, short metal pipes, etc. Then in the workshop the class builds their instruments in an orgy of experimentation. The advantages of this kind of workshop lie in the fact that the kids have collected the materials themselves, experimented with the concepts and realities of sound and vibration, and created their own orchestra of instruments. This kind of hands-on approach is infinitely better than just showing students instruments and explaining how they work.

Math

Music and math are so closely interrelated that you simply cannot have one without the other. Simple instruments can be useful in many kinds of math-related activities. For example, elementary school teachers often complain to me that their kids don't "get" fractions. My feeling about this is that teaching fractions as a system without relation to real-life applications is basically worthless. It is vital to show how fractions relate to the real world, and music is one example. Musical notes — whole notes, half notes, quarter notes, etc. are of course fraction-based. A class, using their instruments that they have constructed can create and perform a piece based on the fraction values of musical notes, thus showing one real-life application of fractions.

Another math and music connection is in base numbers and matrices. Our standard base number is base 10 — because we have 10 fingers. In other words, once we have reached 10, we start over, with 10+1 (11), 10+2 (12), etc. But some of our systems are not base 10, for example, time is measured in base 60 (60 seconds, 60 minutes, etc.). Music is often in base 4 (4/4 time) or other base numbers — base 6, base 5, etc.

Using the concept of base 8 (eight eighth notes) students can create rhythms by using a matrix:

Each box in the matrix represents an eighth note. Boxes with something in them represent a played note, empty boxes a rest. So, assuming we are using shakers and horns, a simple ostinato might be:

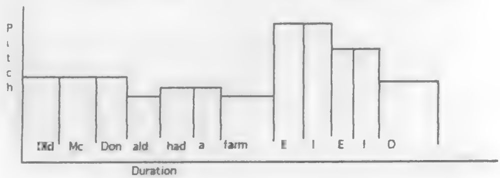
S	S	H		S	SS	H	

Two 8th-note shakes, 1 horn, 1 rest, 1 shake, two 16th-note shakes, one 8th horn, 1 rest.

Note the flexibility of this system — it is possible to subdivide the 8ths to 16th (as in the sixth box) or even to 16th note triplets.

One of the complaints about using simple instruments in the classroom is that elementary school students do not know musical notation. By using a simple system such as the rhythm matrix it is possible to create useful ostinatos. But what about pitch?

Another way to show pitch is by using bar graphs. Bar graphs are part of the elementary school curriculum starting usually around grade 3. Here is "Old McDonald" using a bar graph:



This simple form of notation can solve the problem of pitch. Note that the thickness of each bar represents the duration of the note.

Depending on the kind of simple instrument you build in the classroom, exact pitches may or may not exist, but at least you can create a "pitch contour" using this kind of notation.

Using the simple notational ideas above, it is possible for students to create and compose musical pieces using their simple instruments, and, in the process, make connections to math.

Science

Creating musical instruments has so much to do with science that it seems to be duh-simple. After all, energy transfer, lengths of vibrating objects, waves and so forth are just part of the process of building instruments.

The science of acoustics has a major translation problem, however, and that is that acoustics basically deals with frequency of waves — a subject that is guaranteed to glaze over the eyes of most elementary school kids. However, the observable phenomena of acoustics are just perfect for students of that age. These phenomena can be boiled down to the following:

Pitch:

longer = lower and shorter = higher
looser = lower and tighter = higher
less dense = lower and denser = higher

Volume:

Strings need a resonator to sound louder
Winds (except those with toneholes) sound louder with a funnel

Of course this is a vastly simplified set of observations and missing many nuances. But all these are easily shown with simple musical instruments:

Pitch:

Buzz your lips through a long tube and the pitch is lower; shorter is higher
Pluck a loose string and the pitch is lower; tighter is higher
Hit a piece of softwood (maple) and the pitch is lower; hardwood (cherry) is higher

Volume:

Play a rubber band stretched across the fingers and the sound is soft; wrap it around a box and the sound is louder
Buzz your lips through a cylindrical tube and the sound is softer; buzz through a conical bore (funnel shape) and the sound is louder

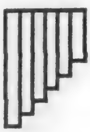
These are the kinds of things that will appeal to an elementary school student and are easily done using simple instruments. Furthermore, when that elementary student moves on and takes physics in high school or middle school, those observations will continue to help them understand the more difficult concepts introduced there.

Following is a concrete example of a simple instrument that also relates to science, math and music:

Diatonic Straw panpipes: Cut a piece of straw, block off the bottom with your finger and blow over the top. Check the resulting pitch on a piano and trim the straw to the desired pitch. Use a hot glue gun to put a dab of glue into the bottom of the straw to close the end. Cut other straws by using the whole step/half step ratio to get the correct pitches for a diatonic scale. Following are possible straw lengths to create a straw panpipe:

7 inches, 6 and 6/16ths, 5 and 12/16ths, 5 and 8/16ths, 4 and 14/16ths, 4 and 5/16ths, 3 and 12/16ths, 3 and 8/16ths

I started with 7 inches merely because typical straws do not go much longer than that. Place the cut and hot-glued straws on a piece of masking tape with the top ends even (for easier blowing) and you have your straw panpipe.



etc.

Another benefit of this instrument is that it gives students a way to clearly see the whole step/half step construction of a scale in a visual rather than aural way.

Cultural Studies

At several points in elementary school curricula there are opportunities to study different cultures, usually first as communities, and then several grades later as distinct cultures. Simple classroom instruments can help give to the students a deeper understanding of how and why other cultures function.

A simple way of looking at the art of another culture would be to listen to music from that culture and build similar instruments. But to take it further would be to examine the resources that a particular culture has as reflected by what they build their instruments out of. For example, a culture that lives in a rain forest quite probably would build some instruments out of that all purpose plant — the bamboo. Another culture living in a semi-arid place might be prone to building instruments from clay, or from animal remains (bones, horns, etc.).

Another way to look at cultures is by mere orchestration. For example, two of the major musical styles of the Caribbean are salsa and merengue. If you trace the roots of the musical instruments used in these styles you find the three-fold roots of much of the Latin Caribbean cultures — European, African and Native American (such as the Taino Indians of Puerto Rico). Keyboards, brass and guitars come from Europe, drums, maracas, guiros, etc. from Africa and Native American cultures. Right there you have a lesson on how the Europeans came into the new world and introduced African slaves. The resulting mix is a large factor in the shaping of Latin American culture.

One thing that never fails to impress me is that through history, when cultures merge (through invasion, famine, disaster etc.), the military and political organization of one tends to annihilate the other; the arts of each usually meld to form a new kind of art.

Literacy

When I first started teaching eleven years ago, the first cultural institution that I worked with was dedicated to helping students read better through the arts. This approach has over the years been embraced by many, many other groups. There is such a huge push on literacy these days that it seems to overshadow all the other core curricula.

There are many ways to further literacy using classroom instruments, but one of my favorite approaches is to tell stories by using the sounds of instruments.

In a typical such program, in the first session the students are introduced to the concepts of building instruments from trash. The second session (and perhaps part of a third) are devoted to actually building the instruments. In the third session we also make a catalog of sounds of the musical instruments: "thump", "clang", "boing", "shake", etc. Then we see what those sounds could represent. For example thumping could be sound of elephants stampeding, or simple footsteps, or thunder. Shaking sounds could be the sound of a rattlesnake, or rain. And so forth.

At that point the students will write a story using the sounds of those musical instruments to help to tell the story. In the next session some of the students would read their stories as the rest of the class performs the sounds with their instruments. All of this could eventually lead to a stage performance where the class could demonstrate their stories and instruments.

The real benefits of this is that many students get very excited when they find they can integrate music into their stories. I feel that so many kids are stimulated by television and movies where many arts are folded into the storylines — music, visual, acting, and so forth, that they find their own written stories to be somewhat dull.

I have had some fantastic results from these workshops. I have had teachers tell me that some students have jumped to write things (and volunteer to read them aloud!) who have never written enthusiastically before. I feel that this is something that the arts offer — a way to reach kids who just don't react to rote learning. Maybe they are not being stimulated in the way that they need.

CONCLUSIONS

The process of building musical instruments is one in which there is a confluence of ideas. To build the instrument you must have materials. You must have knowledge of how sound works, and how instruments work. You have to have the forethought to design and plan your instrument. You have to have the tools to build your instrument. A certain amount of 'spirit' (for lack of a better word) goes into the building of the instrument. Finally you must have the ambition and love and ability to play that instrument.

I think of education the same way. The same kinds of processes that go into building a musical instrument also go into building a student and citizen. We, as teachers, can help that building process, and hope that we can impart some of our fears and wishes. But in the final analysis it is only the student's ambition and love and ability that will truly shape the instrument that they will become.

John Bertles is an instrument builder, educator and composer. He founded Bash the Trash® in 1987 as an educational group dedicated to building musical instruments from trash, and then making connections to the core curricula. Some of the instrument he has (re)invented are the Bendjo, the Bobby Piano and the Tilimba. In recent years he has worked as a program and staff development consultant for Carnegie Hall, the Grammy Awards, the New York Philharmonic, and Manhattan School of Music. He lives in the first small town outside of New York City with his wife (a choreographer), son and a small dog.

You can email John at jbertles@idt.net, or visit the Bash the Trash website at www.geocities.com/athens/acropolis/5732 (soon to be changed to bashthetrash.com).

NO UNIFYING IDEA IN THE WORK OF NO ONE IN PARTICULAR

By John Berndt

The intention I claim for my work with unusual sound sources and instruments is this: I follow my wandering interests regardless of where they lead me, and I have little time for my own or outside conventions. The intellectual pattern or process of this work alternates between metaphysical imaginings and extremely pragmatic hobbyist engineering—tinkering with often whimsically chosen material. The result is a body of work that I think is aesthetically incoherent, and full of apparent disassociation of sensibility. More often than not, my instruments are intentionally "opaque" compared to the instruments of classical traditions, in that they do not reinforce the notion of a "top-down," "universal" music where it is easy to separate the musical/aesthetic conceptions from the physicality of the instrument. (I am looking for universes of sound that do not cross-reduce; I consider "universal" theories of music or sound to be pretentious and misguided.)

THE VENETIAN GLASS NEPHEW INSTRUMENT

This is an amplified pane of ¼"-thick frosted glass which is held from below by a four-point support attached to the top of a tripod... these are towards the center of the pane. A Piezo transducer amplifies the sound of the glass, which is quite resonant with a pronounced, liquidy fundamental frequency. The glass provides an unexpectedly rich sonic palette when it is properly explored. So far I have found a wide range of ways to play this instrument, and I imagine I will find many more.

Inspiration comes slowly

First, I use a series of mechanical wind-up "doll hearts" (pieces of wind-up toys I found at a salvage store) as a way of setting up reverberations of different wavelengths in the pane. Each "doll heart" emits a pattern of regular clicks which eventually slow down as the tension releases from a band-spring. When the hearts are placed on the glass, the glass conducts their position, and moving their position alters the tone of the clicks (presumably as they articulate different resonances in the glass). A few "doll hearts" at once produce a buzz of clicks which are an interesting sound texture with plenty of micro-detail. Another effect is produced when the doll hearts wind down and begin to click erratically, producing "random" rhythmic patterns. A strange kind of mechanical feedback takes place where any sharp sounds (including the sound of another doll heart clicking) can trigger gasps of clicks from one that has run out of steam *almost*, i.e. just enough tension in the spring to react to a loud vibration.

Second, I have a wooden frame strung across with round-wound low guitar strings which I use to bow the edge of the glass. Essentially clicking the edge of the glass at a speed just fast enough to produce a tone, the result of the bowing is for the sound to sweep through the overtone series of the glass, producing blurry, overlapping melodies. For some reason, these are extremely evocative of a harp, especially if artificial harmonies are added to the sound with digital equipment, such as pitch shifting or harmonizing.

Third, I sometimes play the glass using X-acto blades to articulate the surface of the glass. Long screams and screeches... difficult to control; piercing. Last, my favorite and richest technique is to play the edge of the glass using the striker from a flexatone. This is a thin flexible strip of metal weighted with a wooden ball on one end. By placing it on the glass and allowing it to rhythmically flap off the end, all sorts of things become possible. By moving the position of the striker, different overtone notes of the glass are articulated, creating rich melodies. The rhythmic characteristics of one or more of these flapping strikers are very interesting, as various sorts of deceleration, phasing, and interference pattern effects are possible.

THE "PEASANT" INSTRUMENT

This is another "elemental" instrument in which a single sound source is plumbed for a wide range of sounds by pure technique. It is called the Peasant Instrument because I thought calling it "the

Left: Venetian Glass Nephew with various articulators.

Right: A doll heart

All photos in this article by Kate Turney

Left: Venetian Glass Nephew and Appologene

Right: Peasant Instrument

ho" would be derogatory in this era. I built this instrument in fifteen minutes using the handle from a hoe, a C-clamp, two eye-bolts, a heavy-gauge spring and a long piece of piano wire, and I continue to get great new things out of it. The basic setup is a vertical monochord which stretches the length of the hoe handle and is pulled out by a bridge, which separates the string into two segments, one of which terminates in a spring which makes that segment ring decidedly cloudy, inharmonic tones. At the base of the longer, non-spring string segment is a guitar pickup mounted in the jaw bone of an ass. The instrument is a sort of "Devil's Fiddle," I guess, because it can be struck on the floor, scraped, plucked, bowed, and beaten on all its parts to produce a wide range of reverberating, resonant sounds, and it also is sometimes a herald of chaos. I have tried to develop technique that involves mining all the possible timbres of the instrument to find new sounds and to gain virtuostic control of those I already know.

I play the Peasant Instrument in an ever-expanding variety of ways. Bowing it on the open string, above and below "stopped" points on the string, above and below hemostats I add to divide the string, and so forth gives a variety of roughly cello/piano type timbres, although without the devices for pitch location of those instruments. Techniques that involve changing string tension, stopping the string or sounding harmonics or half-stopped notes are highly developed and continuously interconnected. (I like working improvisationally in an undefined pitch space "by ear"—this is central to what I do in my duo "∴THUS" with Neil Feather, for instance).

Striking the string or body of the instrument with the backside of a bow, or with guitar slides, or with other implements brings

forth a variety of percussive or guitar-like timbres. The extreme end of those techniques involves placing the instrument across my lap and playing the body and both the segments of the strings with two thin metal rods. The resulting, usually rhythmically driving, tonal sound owes a lot to influence from my friend Bradford Reed's "Pencillina" playing. I also have a technique where I play in roughly blues tonalities using two slides and a volume pedal, which sounds very much like extended guitar technique (with a long slide range). A final aspect of the Peasant Instrument is the presence of saxophone reeds pushed between the pickup and the jawbone base. These wooden splints poke out and can be bowed (or struck) to produce "Daxophone"-esque vocal squeals, groans and notes which are resonated by the sympathetic long string. Bow pressure on the reed dramatically changes the pitch and timbre that is then conducted through the harmonic and inharmonic legs of the string, much like the sympathetic strings in Indian music.

THE STEPHANIE PALMER APPOLOGETICA

Attributed to a turn-of-the century inventor of parlor games (without a shred of evidence to support this), this family of instruments is among the most basic ideas I have worked on. Essentially they are long pieces of flexible plastic tubing joined to a saxophone, clarinet, or bird-call mouthpiece one end and a funnel on the other with tone holes placed "randomly" for finger convenience. I gave them names based around their length and quality: The Appologetica, The Appologene, The Appologoid, etc. Long before I was a saxophonist I was practicing my extended reed technique (without any conventional technique at that time, I might add) on these long tubes, which generally gave a response close to a bass clarinet tone.

Because of the long tube, bass clarinet-flavored multiphonics and embouchure-forcing for a wide and clear harmonic series were possible. The "arbitrary" intervals of the tone holes suggested new music and pitch sonorities that I found enchanting, and occasionally I would also whirl the tubes over my head to provide rotary-speaker effects. I had one innovation with the Appologetica, which was to stretch a balloon across the open face of the funnel at the end with a small circular hole in the middle for sound and air pressure to escape. The result is a kind of mute which darkens the overall tone and adds to the multiphonic possibilities.

THE SPORADICA

For a long time I had wanted a drone instrument which would provide a sustained string sound to accompany modal soprano saxophone solos. I also had an idea about building an instrument that would use a rather obscure kind of string articulation to produce complex tones. I've always been fascinated by the semi-stopped string (not full stopped, as in fretting, or stopped at a harmonic node, but interfered with to produce an altered harmonic balance, like the threads in the Indian Tambura). These two interests came together in the "Sporadica," a magnetically driven monochord built from the body of a trashed Persian autoharp, outfitted with a guitar pickup and a velcro-attached E-Bow. The E-Bow is a commercially available device that uses a magnetic field to resonate a steel string without touching it. In the case of the Sporadica, the E-Bow not only sounds the string, but it also "semi-stops" the string with its underside to produce harmonic interference. In its "simple mode," this provides a complex drone of stable and tunable pitch but with emphasized and pulsating harmonics. In its more complicated uses, I tune the string way down so it droops physically below the E-Bow's magnetic field in its relaxed state, insert a bridge in the middle of the string, and bend the string from behind bridges at either end with a rather developed technique. The resulting sound is extremely varied and includes swooping or slow moving glissandos, heterodynic effects, and extremely expressive vocal sounds that are reminiscent of Curly of the Three Stooges making sounds of anxiety. It is also possible, through an adept approach to changing the string's tension, to coax the string into a high harmonic level and so to get a wider pitch range. I consider the Sporadica to be one of my most successful instruments because it always takes me somewhere new and has its own, highly integral logic.

FEEDBACK (THE "PROPOSITIONAL CALCULUS")

My earliest music was electronic music and tape music, an obsession from well before puberty, which I always approached in a rather perverse and iconoclastic manner. In the mid '80s, I also did a large amount of work I liked with modular synthesizers and MIDI systems but felt eventually that I had exhausted those approaches, at least for the time being. So, I sold or gave away all of that equipment and began improvising with more elemental sound sources such as amplified balloons, building new instruments, and playing conventional instruments in "unusual" ways. I never lost my interest in electronic sound, but it was sidelined for awhile until I started working with feedback, which revived my interest. Feedback generated through a circularly patched mixing board was a more elemental, pliable, organic, self-referential, non-linear, illogical material to work with. Along the way,

Sporadica

hearing Lou Reed's excellent "Metal Machine Music" and the music of David Meyers (see his article in *EMI* Volume 6 #5, Feb 1991), and other similar works added additional inspiration, even if my work sounded fairly different. There are a lot of things to say about feedback music, but for the sake of brevity I will just mention a few crucial considerations. First, in feedback, pitch, timbre and volume are not independent but inter-relate in a complex way. Thus, altering the volume of a feedback loop may change its tone and apparent pitch in counter-intuitive ways. Second, feedback, especially through a compressor, tends to "find its own level" which means that the total tendency of the system is to oscillate in a rather static manner, hence the need for processors to make things "more interesting." Lastly, time-based modifiers such as delays "slow down" the process of the feedback and make the iterations and permutations of its development more visible... to the ear. In the case of choruses and flangers, they produce stepped, microtonal melodies with changing timbres. These days I have an extremely developed feedback music system I carry in a case which breaks out to form two tables of electronics on tripods. The sprawling "Propositional Calculus" system is an "instrument" of bought and modified processors, a small Mackie mixing board, a ton of patch cables, and several switching boxes I built to allow me to rhythmically articulate (or switch on and off) the different (often intersecting) feedback loops I have going. The processors include a digital reverb/multi-effects processor, a stereo compressor/limiter/noise gate with side-chaining, five tremelo boxes, an automatic filter, and two heavily modified digital delays (see below). I place a constraint on myself that each time I use the system I will patch it differently, which in improvisation means I have to learn the idiosyncrasies of the non-linear controls in real time. I love this instrument because it has such a vast range and yet is very difficult to predict, and I strive to get sounds from it which are not identifiable as electronic, or at least not cliches of electronic music. Sometime I joke that I am "reinventing the analog synthesizer, only more expensive and powered by nine-volt batteries," but actually what I do with the system would be hard to achieve by any other means.

Dictal Robitary

RECOMBINATE ELECTRONICS
("Insect Brain" and "Dictal Robitary")

EMI has featured great, generous articles on "circuit bending" by Q. R. Ghazala, whose Incantor instrument I proudly play all over the place. My own inspiration for disregarding the "qualified technicians only" stickers and prying into the guts of digital electronics came earlier from my friend John Sheehan, who impressed me with a wide variety of cannibalized noisemakers and showed me how to hold a soldering iron. (I use Sheehan's term Recombinate Electronics to confuse the issue). I learned to avoid the power pins on IC chips and to probe relentlessly for interesting short-circuits. When I found one, I would hard-wire it with some sort of switch to make it into an optional effect. I began by modifying Casio SK1 keyboards and other 4- and 8- bit samplers which could be got at yard sales for $15... popular targets because they admit to easy modification, are complex, and seem non-precious. After giving away a number of different modified boards, I began to build a device that integrated three different brands of these keyboards into a wooden frame. This "Dictal Robitary"* allowed for a variety of different kinds of sample modifications on three separate samplers, ranging from quasi-ring-modulation to chopping the sample into asymmetric bits and rearranging their order, to driving the cheesy rhythm and accompaniment features insane. The "innovation" here is that the three circuit boards can speak to each other, usually with fairly complex and noisy results, as well as having their own "internal" bends. A freak accident of circuit bending led to the mutation of one of the keyboards into a bizarre, uncontrollable golem which makes amazing sounds and can go for hours without repeating itself, and yields only to only vague control from the outside. Things like that just make my day.

Emboldened by my success with the "Dictal Robitary," I began to look at two Digitech 2- and 8-second digital delays sitting dusty on my shelf with a wolfish grin. I always had a "love/hate" relationship with delays; I like the fact that they create time dissociations, but dislike the fact that what comes back later is a repeat of what happened before! So I began to modify these delays, which turned them into the "Insect Brains" they are today. They still function as they were originally intended, but also provide a very wide range of multi-selectable idiosyncratic special effects which have yet to be named by anyone but cross the same terrain as (hybrids of) ring-modulation, tremolo, vibrato, pitch shift, reversing the sound, and so forth. When the "regeneration" of the delays is turned up, they produce interesting, stepped melodies of distinctly Eastern-European flavor with no input. Used in my feedback system, they are prime movers of dissociation, fragmentation and chaos.

CAN'T GET ENOUGH OF THAT MISCELLANEOUS ACTION

For the sake of brevity I'll zip through a number of other instruments which are less developed but still may have some interest. The *Dry Heaves* is a large stainless steel mixing bowl which is played in a variety of ways

*See "Plan Nine from Outer Space," by Ed Wood, for the technical details.

with two stainless steel Chinese exercise balls that makes a very WET sound, without any water. The *Alto Bladder* is an inflated balloon within a deflated balloon, with the outer balloon serving as the resonator for an alto saxophone mouthpiece; deeply unstable. The *Ben Wa* is a thick plastic tube with an alto sax mouthpiece attached and two ben wa balls that roll inside the tube, creating a natural sort of phasing effect and destabilized intonation in an interesting way as the player rocks the instrument forward and back. The *Rubber Airplane* is a hanging mobile of various circular saw blades and heavy car suspension springs which float over an electromagnetic pickup which conducts their somber, growling overtones. The *Broncophone* is a tripod with a long spring attached to a face-down stainless-steel mixing bowl in which resides an electronic Bronco toy that kicks intermittently at the whole deeply pitched inverted dome; its tripod also forms the base for the Sporadica. The *Cephalaphone* is a contra-bass clarinet body that has a blown membrane instead of a mouthpiece and captures a surprising range with a very altered tone. The *Gamelan-Son-of-Tiddy-Bowl* are a series of fairly ignorant gong and struck-tyne type instruments made from stainless steel bed pans (great sound) and tuned by ear with a hack saw; instruments for a personal cargo-cult. The Conversation is a toy telephone made from two plastic cups joined by a long wire; by singing into it and changing the length of the wire, interesting bending sympathetic overtones are evoked, sounding very electronic without electronics.

AN EXPLANATION BY REDUCTION

My work with instruments admits to no summing up, nor do I consider it to even be particularly personal to me, though it is a source of great joy and personal inspiration. **The issue seems to be escaping banality — any academic view of reality.** Though this article may seem to be about whimsical pedestrian-empirical-sound experimentation, the motivation for that experimentation, the sensibility, remains an open question for me.

Many thanks to my long-time collaborator and mentor Neil Feather, my girlfriend Kate, Bart Hopkin, and the entire Red Room clique for their support of my work and this article. Also special thanks to Dr. Al Ackerman, who very irresponsibly named many of these instruments for me immediately after their concert premiers — and the names usually stuck.

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Circuit-Bending and Living Instruments OF A FUTURE

By Q.R. Ghazala

Dogs do not study art. They don't have to. Appreciation of artwork comes naturally to dogs; nothing that is there for dogs is lost. It is the same with cats. A sniff, a raised tail... and all is well.

Oh, should it be so easy!

Seven years and over one hundred pages ago I decided to accept the offer to write about circuit-bending for EMI. I was reluctant knowing I was a clumsy writer and fearing my focus was too obscure. While the former has remained a constant {and thanks for your perseverance}, the latter I've found to be much less the case. The four thousand e-mails to handle last year, along with all of our uncle's snails, came non-stop and contained the usual recurring themes.

This last article then will be an attempt to cover ground most requested, yet still untrod, within my tenure here... ... ...

:OF A FUTURE *by Q.R. Ghazala*

(continued from prev ious page)

The two main information requests I get are:

What target instruments should I be on the lookout for to circuit-bend?

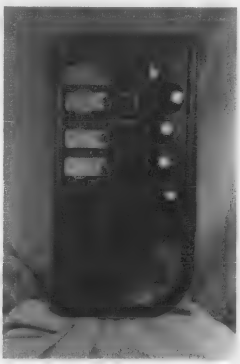
What exactly do I have to know to build these instruments myself?

Devoted to these two subjects will be this last telling of anti-theory thought and clear-illogic electronics in the fertile time-capsule of *EMI*.

My usefulness in these pages, and why I decided to appear here, was to hopefully launch other explorers into this new frontier. What follows is a gallery of my instruments interspersed throughout a refined "how-to" text. Some instruments will be familiar to long-time readers, but most appear for the first time. Likewise, some of the instructional ideas have been covered in the past. But you'll find many new tips and procedures outlined as well. Here we go…

1- Incantors. Circuit-bent human voice synthesizers of the Speak & Spell, Speak & Math and Speak & Read line of talking educational games. Incantors produce chance loops, streams of vocal abstractions and unusual tones. Very easy to circuit-bend.

2- Trigon Incantor. Circuit-bent human voice synthesizer based on the Touch & Tell speaking game. Sound production similar to the regular Incantors. Played by positioning the steel balls on the pressure-sensitive playing stage. Very easy to bend



3- Morphium. Machine and animal sound sample bank. Circuit-bent with dials and body-contacts for extreme real-time pitch shifting. The twelve samples can be transformed into exotic abstract lead voices. Worn like an accordion, left hand on body-contacts, right hand on keys. Original device is a train toy. Still found in second-hand shops.

REED GHAZALA'S ART OF CIRCUIT-BENDING

a Bender's Guide

Circuit-bending is the electronic art of the implementation of the creative audio short-circuit. This renegade path of electrons represents a catalytic force capable of exploding new experimental musical forms forward at a velocity previously unknown. Anyone at all can do it; no prior knowledge of electronics is needed. The technique is, without a doubt, the easiest electronic audio design process in existence.

The circuit-bent instrument, often a re-wired audio toy or game, is an alien instrument. Alien in electronic design, alien in voice, alien in musician interface. Through this procedure, all around our planet, a new musical vocabulary is being discovered. A new instrumentarium is being born.

Countless audio gadgets are experimental musical instruments waiting to happen. Circuit-bending's anti-theory approach to electronic design makes accessible to all audio explorers an endless frontier of original sound-forms to discover. And fantastic instruments to create.

Within these adapted devices, along with the unusual voices of circuit-bending, are often found aleatoric music generators. That is, chance-music composers that stream unpredictable audio events, elements shifting and re-combining in fascinating ways.

Body-contacts are also found while circuit-bending. These allow electricity to flow through the player's body, flesh and blood now becoming an active part of the electronic sound circuit. This interface extends players and instruments into each other, creating, in essence, new life forms. An emerging tribe of bio-electronic Audio Sapiens.

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If you learn to solder and can drill a small hole to mount a switch in, you can circuit-bend. Everything else is a process of routine experimentation in which various short-circuits are created in an attempt to alter the target device's audio behavior.

Audio toys not only are easy to circuit-bend, but also are capable of sonic eccentricities beyond belief. The newly implemented line-output's signal, sharpened with EQ and expanded with reverb (standards in the electronic studio), easily stands on its own when fed into an amp or recording console.

Also important, audio toys are low-voltage devices. I suggest you not try

the process with any circuit operating on more than nine volts. Six volts is even better.

Trying to circuit-bend any device operating on the "house-current" of your wall outlet is OUT OF THE QUESTION!!! This holds true even in the instance of AC adapters. Circuit-bending is for BATTERY-POWERED CIRCUITS ONLY. It must be said: playing around with the live circuit of anything plugged into your wall outlet can kill you, as in dead, a pretty serious medical condition. Don't do it.

There is the rare chance, in this try-at-your-own-risk art, that a component might overheat and burn out. Or even pop. In my 30+ years of bending circuits such a pop has only happened once. An external power supply of too high a voltage was accidentally applied to the circuit. Half a transistor was shot across the room. Yes, it was a nice little flash... an angular, blue, miniature explosion. Even though I've never experienced such a thing while bending a device operating on its own correct internal batteries, I must suggest that eye protection be worn.

Photographs on these pages:

INSTRUMENTS BY QUBAIS REED GHAZALA

Photos by Q.R. Ghazalaa

More likely, the downside of this odd art is the chance of destroying the target device through overheating an internal micro-component within an integrated circuit. This occurs rarely, but it does happen. However, circuit-benders find this occasion out-weighed not only by the unique instruments capable of being created and the fact that experienced benders find more successes than failures, but also by the availability to buy audio toys, even complex sampling keyboards and human voice generators, for a few dollars each at second-hand shops. These outlets will supply the bender's workshop with a differing and endless supply of experimental musical instruments to discover.

Perfect targets for circuit-bending are audio games and toys that already produce interesting, good-sounding voices. Synthesized human voices and sampled animal, imaginary, musical and concrete sounds reside within many of these gadgets. As mentioned, musical keyboards, even sampling keyboards, turn up at these stores now and then. Keyboards often produce chance (aleatoric) music when circuit-bent. I call these circuit-bent instruments Aleatrons.

Carrying a supply of batteries, "AA"s, "C"s, and "D"s, will allow you to try the devices at the stores before buying.

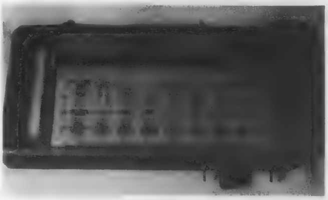
TOOLS

• Low-wattage (30 watts or less) soldering "pencil" (small soldering iron) with a very narrow tip, perhaps filed down for fine work. These are cheap and can be found at the usual electronics outlets. Or, better yet, a soldering station including a cleaning sponge and resting cradle for the pencil. These pencils usually have an assortment of tips available, including the smaller diameter (around 1/16th") that circuit-bending requires. These stations are well worth the additional expense in the long run.

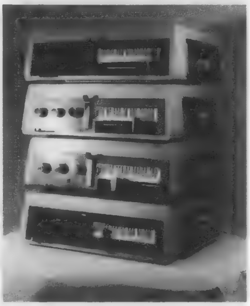
• Thin rosin-core solder.

• Small drill with which to create holes for mounting switches and other components. A hobby drill, such as the Dremel , is handy for this job. A 1/8" bit is used to drill the pilot holes; a ball-shaped "burr" bit of the correct diameter is then used to bring the hole up to the correct size for the component being mounted. Optional: a tapered hand bore. This is a hand tool used to ream-out holes to the correct size; a nice addition to the circuit-bender's bench. This tool will increase the 1/8" pilot holes to the exact size for unusual components or those too large for a Dremel burr bit, as in a 3/4" diameter pilot lamp housing.

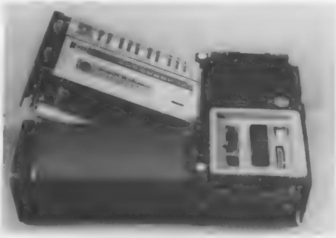
• Set of small, allated "jeweler's" screwdrivers; slotted and Phillips.



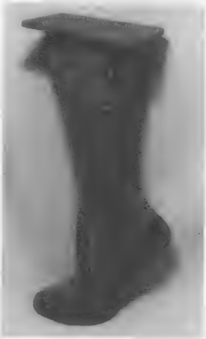
4- Speech Interference Grid. Originally a "Talking Teacher" game, this device has been bent through the addition of a pitch dial and several voice-bending switches. Phoneme generation is altered resulting in a strange alien language synthesizer speaking bass to soprano. Rare, but still found on occasion.



5- IBM Tape Loop Machines. Mechanical rather than electronic bending here. The recording head locator that rests on the drive (worm) gear, slowly drawing the head along the revolving tape loop which has been recorded in a long spiral upon its outside surface just as with an Edison wax cylinder, is adapted so that it can be held away from the gear. This causes the head to become stationary, playing a section of the spiral over and over again. The tape is "skipping" but without the "pop" of a skipping record. The head can now also be swept to any section of the tape loop while in play. If the tape is recorded with the different notes of an instrument while the head gear is engaged (thusly drawing the head slowly along the revolving loop), and the notes are the same notes of the scale as appear on the (added) keyboard graphic behind the moving head pointer, then later sweeping the head to the indicated note while in play mode will play that note. This results in an odd, lo-fi, monophonic Mellotron-like device. Of course, polyphonic instruments, or any sounds at all, can be recorded on the tape loop for later playback. In fact, recordings can even be made while the head is being swept along the revolving loop so that in playback with the head engaged upon the slow worm drive a long sound collage with its own peculiar cyclic and evolving elements is created. This was a secretarial dictation machine in less-bent times. Pause and Play foot pedals can still be found for these rare old audio machines.



6- Miniature IBM Tape Loop Machines. Essentially the same as the larger version when drive-modified. Odd battery, hard to find. External DC power supply can be easily built.



7- Thunder Rattle. Spring-style reverb/amp system creates the familiar reverb crash that bumping these units is famous for. Volume/feedback dial, speaker at the top... the leg chamber is coated with soft, sculpted silicone containing tiny LEDs that flash with the crashes. The reverb unit comes from a large toy castle containing the device in the form of a wolf-headed mic/spring chamber, with remote attached amp.

8- Adapted Electric Bass. Frets removed and filled, body cut back, Barcus Berry acoustic pick-up added to the electronics Electric and acoustic pick-ups can be switched and combined, the acoustic giving a warm and mellow response from solid wood body vibrations.

- Set of miniature crescent wrenches (Craftsman, Sears stores; for fastening all panel-mounted controls).
- Small wire clippers.
- Small wire stripper capable of stripping wire as thin as 30 to 25 gauge.
- Test leads (insulated wire terminated at each end with an alligator clip).
- Optional: resistance substitution wheel. This device, containing assorted resistors of increasing values selected by the turning of a dial, is clipped by means of its two leads into a live circuit so that the selected resister's effect on the circuit can be heard. This will help determine the correct resistance or resistance range needed at a circuit point so that a resistor or potentiometer of the correct value can be soldered in place.

In fact, a custom circuit-bending console tool can be built in the form of an elaborate substitution box. This would be, essentially, a housing containing selectable (via multi-position rotary switches) components to run the circuit-bending paths through — various resistors, capacitors, potentiometers, sensors, LEDs, etc.). Like the resistance substitution wheel, this would be another two-lead device, clipped between two circuit-bending points and adjusted to observe audio changes within the operating circuit.

PARTS

- Miniature toggle switches.
- Miniature push-button switches.
- Assorted resistors.
- Assorted potentiometers (variable resistors, as in the familiar volume control) in values from 50 ohm to 10 meg.
- Assorted photo cells (light-sensitive variable resistors).
- Assorted capacitors.
- Assorted body-contacts (any metal knobs, etc., that can be wired to the circuit and bolted to the instrument's case).
- Assorted panel-mount audio output jacks (1/4" "guitar jacks", RCA "phono jacks", 1/8" miniature jacks, etc.).
- Assorted LEDs.
- Several colors of insulated 30 or 25 gauge "wire wrap" solid-core wire.
- Assorted other small-to-medium-gauge wire... solid core, stranded, bare, insulated.

NOTE: While nearly all the above tools and parts are available at the well-known electronics outlets at premium prices, they are also available through numerous mail order electronic surplus outfits as well as through surplus warehouses to visit in person. Not only are these prices so much better, but often the quality of items is higher than the flimsy parts offered by the majors in the malls. In addition, surplus retailers acquire very strange parts to work with, odd designs to be found nowhere else.

EXPLORING THE ART

Before your first circuit-bending project, if you've never used the above equipment before, buy and build a beginner's electronic kit. An LED flasher, a digital clock, an integrated circuit noise maker... anything that will familiarize you with soldering, wire clipping and stripping, etc.... the basics of electronic circuit-building.

Reading a beginner's electronics book is highly recommended. "Getting Started in Electronics" by Forrest Mims Jr., and available at Radio Shack, is a good place to begin. There also exists a small "Engineer's Notebook" series by the same author. These handbooks get into more advanced subjects as well, but also cover the basics of circuit construction in one or two early volumes.

Beginner's guides will explain nice-to-know terms and cover how switches, potentiometers, resistors, capacitors, LEDs and other components operate. Circuit-bending will eventually teach all this, but it's much better to enter with a general understanding of these basics that must fall outside the scope of this present writing.

So... how does circuit-bending work?

First, clip the smallest two metal jeweler's screwdrivers in the alligator clips at the ends of the test lead. This gives you a wire with a probe at each end, and is your most important circuit-bending tool. (Obviously, a custom test lead with a permanent probe at each end can be made for this job, as well as the elaborate console described at the end of the tools section above).

Remove the back from the game or toy to expose the circuitry.

Turn the device on and activate the sounds (press keys/buttons, or tape/wedge in place to sustain sound production).

With the device *making a noise*, press the tip of one of the test lead's screwdrivers to a printed circuit trace, component lead or integrated circuit pin. Keep this screwdriver tip in place for the next step.

Now, with the other screwdriver at the opposite end of the test lead, begin touching various parts of the circuitry while listening for interesting changes in sound.

Electricity will follow the new course you've provided with the lead. This may have no effect on the sound at all. On the other hand, the audio effect may be outrageous.

Each time an interesting sound is created, note with a marker directly on the circuit board the pair of points that were connected to each other to create the sound.

Once the traveling end of the test lead has explored the circuit's corners and all interesting connections have been noted, place the stationary screwdriver tip on a new circuit point.

Again, the traveling end of the test lead explores the rest of the circuit; interesting sound-changing connections are marked.

This process is repeated until the entire circuit has been searched in such a manner.

Given a bit of luck, the circuit will soon be marked with a number of potential connections discovered with the test lead.

At this point, various choices face the explorer in implementing the creative short-circuits discovered:

Direct wiring

Wires can be soldered directly between the points marked as pairs on the circuit board. In the middle of these wires would be soldered toggle switches so that these new sound-activating connections can be turned on and off at will. Use the simple mini toggle switch, the common "SPDT" (Single Pole, Double Throw). One wire will go to the switch's middle terminal, the other will go to the terminal *opposite* the direction of the switch's toggle handle when in the *on* position. These toggle switches can usually be mounted on the device's housing, creating the new control panel. If you are using "SPST"s (Single Pole, Single Throw), there will be only two contacts to solder to; either of the two wires of your pair can go to either terminal.

Note: It is assumed that the soldering skills of the bender (you) are such that quick and precise connections can be made. This is important and not hard to learn. Quick, because some components can be damaged by the heat of excess soldering, especially since the bender may at times find it necessary to solder directly to integrated circuit (IC) pins leading to micro-miniature delicate electronics inside the IC. Precise, because, as in the example of IC pins, clearances can be minimal. The danger here is accidentally creating a "solder bridge" between IC pins (or other tightly-spaced metals... printed circuit traces, component leads, etc.) that were not meant to be soldered. There are several devices available to remove solder mistakes from a circuit. These work either by heating the solder and drawing it away from the circuit by means of vacuum, or by drawing the heated solder, through osmosis, into a metal braid. Both techniques are a hassle. Practice soldering until you feel comfortable with "quick and precise"; avoid the solder mistakes and their correction tools.

The wiring procedure begins with counting how many pairs of connections you'll need switches for. Next, decide how the switches will be mounted on the device's case (remember to check for internal clearances so that the backs of the new switches don't hit the device's internal parts when the unit is reassembled). Holes are drilled, the switches are mounted, the pairs of circuit-bending connections are then soldered through their respective switches and the device is reassembled.

9- L'esprit en Piege. Circuit-bent sampler circuit cycles between listening to surrounding sounds and playing them back in its new disarray of language. Glass globe contains tarnished antique doll eyes, spring-mounted, above a concave mirror also attached to the spring. An ultra-bright green LED strobes into the mirror, pulsing with the released sounds, and is focused, swaying as an abstract patch of light, on the ceiling above. Electronics are housed in a square chrome chamber beneath. Small samplers abound as toys now. Many can be bent in unusual ways.

10- Solar Touch-Tone. A simple portable touch-tone signal generator with the addition of a solar cell. This cell is wired to a section of the circuit that causes a distinct "flanging" of the sounds when the cell is exposed to light. With a moving hand over the cell for musical expression, the keys can be played with the other for an odd twist on Ma Bell's tonal schizophrenia.

11- Electric Twang Can. An electronic spin-off of the Indian ektara. Here a chopstick attached to the side of a nut can holds taut a thin metal string between its top and the middle of the can's bottom. Inside the can may be placed any type of electronic pick-up capable of registering the sounds of the string's vibration. In the version shown I've attached inside a small microphone whose cord terminates in the 1/4" "guitar jack" output on the side. A miniature washtub bass, this device can be played in the same way, as well as many other ways as the stick is bent and vibrated and the notes are tickled and plucked.

12- Soundpoem Tank. A speaking alphabet toy, circuit-bending has turned this device into a tone-rhyming sound-cycle machine. In addition, the central matrix of 49 LEDs flashes strange patterns where instructive letters should appear. This toy is still available on store shelves

13- Oecanthophone. Tom Wait's insect voice synthesizer. Built into an old Polaroid flash unit known as the "Wink Light", this oddity chirps delicately away as its resistor-capacitor ("r/c") tone-burst circuits are switched, push-buttoned and dialed into being. I think Mr. Waits uses this device to lure bugs from his dungeon into munching range.

Potentiometers

Instead of switches, potentiometers (variable resistors) can be soldered in the middle of the pairs of connections. In many cases this will allow the adjusting of the new effect with the turn of a dial. Potentiometers, like non-adjustable common resistors, come in a variety of values measured in ohms of resistance. Experiment with different values to learn their effects. Potentiometers usually have three soldering points, or lugs. Solder your two wires so that one connects to the middle lug and the other to one of the outside lugs. Which outside lug you choose depends on what you want the effect to sound like as the potentiometer's dial is turned in a pre-determined direction. Example: The volume control on your stereo is a potentiometer. If you were to reverse its outside lug wiring the volume would go DOWN when you turned it up (clockwise).

Switches can be used along with potentiometers between the pair of circuit-bending connections as well. In this way, effects can be pre-set with the potentiometer's knob and turned on and off with the switch. A wire would be soldered to one of the points in a circuit-bending pair, through the toggle switch, then through the potentiometer and back into the circuit-board to the other point of the pair. This switched component wiring may be used with any components, including the following…

Capacitors

Capacitors, again available in a wide range of values, can be wired between the pairs of points. These may change the tone of the effect produced or pulse the sound in differing ways.

Note: Some larger electrolytic capacitors can hold a substantial charge and can transfer it to you in the form of a very real shock. These are cylindrical, two-lead (usually) devices, the ones of concern most often being larger than a cigarette filter. These capacitors appear in the circuitry of strobe lights, power supplies and other higher-voltage dependent applications. They practically *never* appear in the circuits here under discussion. However, all beginner's guides to electronic circuit design cover this subject. If you're not familiar with how the electrolytic capacitor looks, get a guidebook, like the one by Forrest Mims Jr. at Radio Shack, and learn these basics. Such capacitors are easy to recognize and discharge, in the very rare event that you should ever find one in the way.

Photo Resistors

These are light-sensitive buttons (at times called "cadmium sulfide cells") with two wire leads. They convert light into electrical resistance, so to speak. They have the same effect upon a circuit as a potentiometer. However, instead of turning a dial to vary the resistance and thereby the sound, hand shadows are allowed to fall upon the photo resistors. These sensors can be used in many wonderful ways, including environmentally directed instrument designs since ambient light and shadow — tree leaves, water reflections, clouds passing, etc. — may be employed as player.

Solar Cells

These are light-sensitive wafers that convert light into electrical energy. They can be used to inject their small voltage (or resistance in some situations) into the circuit between the paired bending points and change the sound thereby. Of course, wired in series these wafers can be used to supply the operating power to an instrument, connected "end to end" just like, but instead of, batteries.

LEDs

LEDs- (Light Emitting Diodes) are usually, for the sake of circuit-bending, low-voltage light sources. Like all diodes, their core function is to act as a one-way valve for electrons, but their nice glow and long life nearly obliviates this concern in much electronic design. You may find points on the circuit you're bending between which LEDs will glow or pulse. These can

serve as function indicators or pilot lights. An LED wired to the speaker leads may work as an envelope light also, flashing with the intensity of the sound waves.

LEDs are "polarized" components; if they don't glow when connected between promising points on a circuit, try reversing the leads. If they still don't glow, there is not enough power available to activate them. An over-driven LED will burn out. Might even pop. Be aware of the LED that, when tested in a circuit, momentarily lights brightly but then dims to an off-color glow. Or lights too brightly while shifting color. Or simply lights too brightly. These are all signs of too much power being applied. Burn-out will eventually result. LEDs may also affect the sound of the circuit depending upon where they are connected.

Humidity Sensors

These are sensors that convert airborne moisture into electrical resistance (as found in Weather Service "radiosondes", balloon-suspended devices that measure atmospheric conditions and radio this information back to the ground tracking stations). This can give a breath control function to an instrument, changing a pitch, perhaps, as the sensor is blown upon.

There are many other components that can be wired into the path of the pairs of circuit-bending points, but the above will launch hundreds of possibilities as well as pave the way towards the understanding of wider concepts.

To quickly try different components between the discovered pairs of points, a modified test-lead system can be used. This consists of the two screwdrivers as before, two alligator clip test-leads instead of one, and the component to be tested (potentiometer, photo cell, LED, etc.). Clip a screwdriver at one end of each test lead. Between the empty ends of the leads now clip the component to be tested. The screwdrivers again serve as probes with which to search the circuit, now sending the signal through the component clipped in the middle between the two test leads.

Beyond direct electronic component wiring await other expansions...

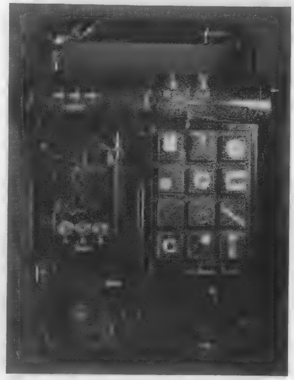
Body Contacts

These are simply metal contacts — drawer knobs, threaded brass light fixture balls, etc. — that are wired to the pair of circuit-bending points. Each of the two circuit points goes to its own body-contact. Nothing is wired between them at all... no switches, potentiometers, sensors... nothing. These contacts, when mounted on the instrument's case, are meant to be bridged by the player's body. This placing of human flesh amidst the circuitry, now conducting electricity as surely as any other component on the board, turns the body into a potentiometer of sorts. A variable human resistor.

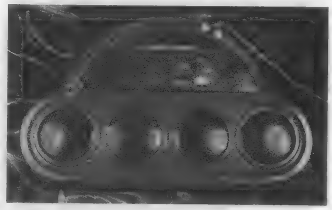
Body-contact circuitry points are discovered in the exact same way as the circuit-bending pairs... with a test lead system. However, instead of the alligator clip test lead grasping a small jeweler's screwdriver at each end, you do. You simply hold a screwdriver in each hand. The search process is the same as before. The circuit makes its usual sounds while you listen to the changes that might occur due to the electricity now flowing into one screwdriver, through you, and out the other screwdriver back into the circuit. If good points are discovered they are wired, as mentioned before, each to a metallic body-contact mounted on the instrument's case. These can then be touched by the player thereby creating the same body-circuit as discovered with a screwdriver in each hand.

Rarely is this electricity ever felt by the player. In a certain 9-volt amplifier, my first circuit-bent instrument, the body-contact system did deliver small shocks. But nothing like the static shocks of wintertime carpet-strolling or, worse, the dangerous shocks that befall most musicians now and again from improperly grounded stage equipment.

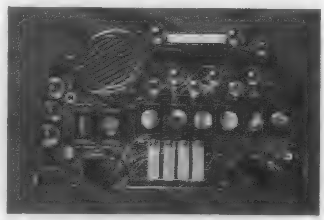
The important note here, however, mentioned before and worth repeating endlessly, is to try these circuit-bending techniques ONLY ON BATTERY-POWERED AUDIO DEVICES OPERATING ON AN ONBOARD BATTERY POWER SUPPLY OF 9 VOLTS OR LESS. Trying to circuit-bend anything plugged into



14- Audiowave Detonator. Once a speaking telephone toy, the voices now can be set to explode apart in mid-stream, disassembling into allophones and noise bits as they scatter into silence. Many circuits such as this can be found both new and second hand.



15- Doppler Wind. Originally a toy drum machine with the expected pads to slap. Now, with the addition of just a frequency dial, the unit's percussion sounds can be extended into long waves of seemingly Doppler-shifted sounds



16- Species Device. This is an elaborate instrument in the line of my Morphiums (see earlier photo). In this example there are thirteen body-contacts, five pitch & effects dials, one photocell light sensor inside a glass fish eye, and two pilot LEDs, a blue for power and a fluctuating red for volume peaks, behind antique winking doll eyes. The round keys are made of antique purple mother-of-pearl buttons from British Navy uniforms; the rectangular keys are of ivory celluloid salvaged from an old piano disassembling itself in the rain.

the "house-current" of your AC wall outlet, directly or through an AC adapter (power supply, power converter, "wall wart", etc.) is OUT OF THE QUESTION!!! NEVER TRY TO CIRCUIT-BEND ANYTHING PLUGGED INTO A WALL OUTLET. Never.

Reset Switch

Circuit-bending, in its anti-theory universe, creates electronic realities that at times are too bizarre for its own electronics to handle. The circuit crashes. Turning it off and back on might reset it, but it might not. Interrupting power from the battery supply may be the only way to reset the circuit. The batteries can be removed, of course, and put back in.

But more conveniently (and safer, since some crashes represent the possibility of circuit damage and resetting should be done quickly), wiring a push-button switch in the middle of one of the two wires connecting the battery compartment to the circuit board will give you instant access to power interruption.

Push-button switches come in two types: "normally open" (or "N.O.", this *makes* the connection when pressed), and "normally closed" (or "N.C.", this *breaks* the connection when pressed. You want the "normally closed" version to break the connection between the batteries and circuit. Mount this switch on the instrument's case where it's out of the way and not likely to be hit by accident.

Line Outputs

"Line" outputs, the electronic audio signals usually fed to a mixer or amplifier, can be derived from the wires going to the speaker of the unit you're working on. Simply solder two more wires to the speaker terminals and solder the other ends of these wires to an output socket of some type (1/4" "guitar" jack outlet, "RCA" phono jack, etc.) mounted on the instrument's case. A standard cable can then be used to make the connection between the new instrument and the other equipment. *But*...

Use a test amp first! This can be an inexpensive, low-watt amp, bought 2nd-hand and driving a small non-critical speaker. Such a system can be found for $20 at Goodwill & Salvation Army outlets, yard sales, pawn shops, the classifieds, etc. As long as the unit has a standard line input to plug into ("tape", "tuner" or "accessory" phono jacks, usually), it will serve the purpose.

The idea here is that unknown signal levels will be sent into the amp during various circuit-bending experiments. This might risk the well-being of the amp or speaker if certain precautions are not followed. So, an expendable amp/speaker is best.

Be sure to have the amp turned all the way down when first determining if the speaker-derived line output will work. Connect the extended speaker wires to the amp's line input. This can be done by clipping one end plug from an input cable (like a standard phono cord) and stripping the insulation off to expose the two wires within. Connect these two wires to the wires you soldered onto the speaker terminals. With the other end plugged into the amp's line input and the new instrument making its sounds, slowly turn up the amp.

If the sound from the amp is louder than the usual line-input signal from a standard source (tape deck, guitar, synth, etc.), the new instrument's output level, coming from the speaker wires, may be too high or "hot". To tame this output a resistor of the correct value can be soldered between one of the instrument's speaker terminals and then to the wire that leads to the amp. Better yet, a miniature potentiometer, called a "trimmer", can be soldered in place of the aforementioned resistor. The trimmer can then be adjusted to set the instrument's output level precisely. Experiment with trimmer values around 5k, but have higher & lower values at hand as well.

Creating line outputs is very important in circuit-bending. The small speakers that most of the circuit-bendable devices come supplied with cannot come near to reproducing the frequencies that the electronics are creating, even before circuit-bending. And after circuit-bending, frequency response can be mind-boggling since clocking speeds are commonly altered. This results in ranges of frequencies that can surpass human hearing at both the high and low ends. A hi-fi reproduction system can illustrate the power of the circuit-bent instrument's voice in wonderful ways. Also, line outputs open the circuit-bent instrument's voices to signal processing; reverb and EQ, namely. These standards of the electronic music studio can expand and sharpen the circuit-bent instrument's voice, as with the voice of any electronic instrument. These signal-processing systems are the counterpart of the acoustic instrument designer's adjustments of body shape for tone and resonance refinement.

Other Techniques

Along with creating new circuit paths, as discussed, replacing components with others of a different style or value will also bend circuits in wonderful ways.

For example, a standard resistor on a circuit board can often be replaced by a potentiometer or photo cell (both are variable resistors). If this is a resistor that had set the pitch of a voice (very common), that voice now becomes tunable, changing frequency with the turn of a dial or the shifting of light. As would follow, a potentiometer can be replaced with a photo cell as well (i.e., the pitch dial/potentiometer of an oscillator could be replaced with a photo cell providing theremin-like, hands-in-space frequency control).

Motion sensors such as mercury, boxed ball, and "tilt" switches can be wired into small devices for dance or gesture-driven instruments.

Two solutions are at hand in the instance of limited space for the mounting of new controls, a predicament the circuit-bender will eventually run into. Circuitry can be completely removed from its original housing and installed in any number of new enclosures. Or, a remote control panel containing the new switches and dials can be constructed and run into the original housing by means of braided or ribbon cable, a type of self-contained color-coded multi-conductor wire.

In the instance of limited space to solder to, as in short component leads, IC pins, etc., study the circuit to see if the area you wish to solder to is connected to an easy-to-get-to trace on the board. This is often the case. A hard-to-get-to resistor lead, for example, within the circuit might connect with a printed-circuit trace that emerges, with full access, on the other side of the board. Soldering to a trace that connects to the desired component elsewhere is the same as soldering to the component lead itself. This technique can be a real tight-space problem-solver.

CAUTIONS

Along with protecting yourself and the components you add to the circuit as you bend it, there are precautions to take that will protect the circuit itself. If you're working with a rare or hard to replace circuit, take heed...

During the exploration process using the test lead to search the circuit for bending points, apply the traveling screwdriver's tip to the various circuit points tested very briefly — just for a moment. In this moment beware of the following conditions.

Don't try the connection again if you observe:

- a spark
- a dimming of electronic displays or lights
- a "pop" from the speaker
- a volume decrease or failure of the sound in progress
- a humming in the speaker
- a component heating up on the board
- batteries heating up

As electricity flows its course through a circuit, the resistance of circuit components often reduces the voltages in the circuit "down stream" of the power supply. These components are meant to operate on these diminished voltages rather than the full voltage of the batteries. Due to this, it's best not to jump the battery voltage into the further away areas of the circuit with your test leads for fear of overloading these components and causing the conditions listed above. Essentially, this means to avoid the area where the battery power enters the circuit board during your initial explorations with the screwdriver/test lead apparatus. Always exercise caution while near the power-supply section of the board.

Another important fact to remember is that while individual new circuit-bending paths may have no adverse effect upon the circuit when they are switched on by themselves, such paths in combination with each other might not be so forgiving. In other words, switch "1" let's say, which activates your first discovered pair of circuit-bending points, adds a nice warble effect to the instrument's voice and works just fine when turned on by itself. Switch "2", which activates your 2nd circuit-bending connection, adds unpredictable pulsing to the instrument's voice and works just fine when turned on by itself. But you notice that when both switches "1" and "2" are turned on at the same time the speaker volume drops or disappears. Or you notice another of the above trouble signs.

As mentioned previously, eccentric circuitry can cause a crash. Battery supply interruption may be needed to reset and safeguard the circuit. This is an important consideration; be sure to install a *Reset Switch* as described toward the end of the "Exploring the Art" section, above, in any instrument prone to crash.

The reality is that the new wiring of circuit-bending is compounded in many convoluted ways as the different controls are combined with each other. This may cause trouble. Be aware of such switching combinations; avoid them or modify the wiring behind them (i.e., find another pair of points to wire one of the switches to; re-test).

On the other hand, this chaotic snowballing of creative short-circuiting is at the essential and surreal heart of this chance process. There is no way to experience all the switching combinations as the wiring is being charted on the board, or while the tests are being made to decide where the new wiring will go. It is not until the instrument is complete that it can be fully explored by the designer, since it is not until then that all discovered connections and new controls are in place at once and can be combined. At that point magic occurs. The alien instrument is explored, revealing itself in ways never evident during the initial, one-effect-at-a-time, discovery process. This is a wonderful moment.

But to the point: good circuit-bending connections create unusual audio behavior without taxing the circuit, without draining power and without any destructive effect upon the electronics at all. Feeling the integrated circuits, resistors and other components on the circuit board while bending is a very good idea. If a connection is made that causes a component to become unusually hot (some components will warm up a bit normally), avoiding that connection might be a good idea!

It's best to avoid using AC adapters to power circuit-bent instruments. This is because such power converters are known to add noise to circuits as well as damage electronics due to poor voltage regulation and inadequate surge suppression. Use high-quality rechargeable batteries with back-ups.

Along the course of circuit-bending some circuits will be destroyed. As a general rule, never try to circuit-bend anything you can't live without. Experience, however, will lead to more successes than failures, and in time a fascinating collection of instruments will come about.

CLOSING WORDS

Circuit-bending, for the most part, is self-illustrative. Following these guidelines the art will begin to unfold itself to the experimenter.

While this discussion has remained fairly topical to construction techniques, much of the intrigue of this new art lies in the growing extra-technical anti-theory it illustrates as well as the new contemplations of music that circuit-bending forces.

The art born of the composer in addressing these new instrument sounds, in arranging, in being sensitive to the instrument's requests and in setting appropriate themes, will become circuit-bending's fine aesthetic. Here is the greatest challenge, and herein await the greatest rewards.

Circuit-bending is poised at the brink of a future. But like a wooden arrow aside a foggy road, it can only point toward the next bend. So let us dream a future, you and I, and continue to leave our signposts in the sand.

Ah... *EMI*. It's been a tail-wagger, hasn't it?

THANKS

First, a note of thanks I'd like to extend to all the people who've valued this article series over the years. I hope I've tripped a few new ideas. Thanks also to those who've put up with this admittedly odd column taking up the space it has in the otherwise more level-headed *EMI*. My great thanks to all persons who've written to me over the years. You've taught me a lot and your reflections have been an inspiration. Thanks to the Argonauts: the new designers who've taken up "the short heard 'round the world" themselves. Thanks to the new music adventurers who've trusted me to design their alien instruments. And thank you, Bart Hopkin, for both the opportunity to be me, and to be me here. To everyone, I bow deep.

My explorations continue. I intend to publish the occasional article on-line at www.anti-theory.com. My hope is also to contribute more of the same to an EMI off-shoot that may, if all goes well, take shape in the coming months. Until we meet again, farewell friends.

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STRAWS IN THE WIND, or, The Wind in the Willows

Text and Illustrations by Robin Goodfellow

A musical instrument may acquire extra-musical connotations related to status. Thus a violin is suitable for elegant society, but a fiddle (same construction, different name) calls to mind hoedowns, not drawing rooms. So also Pan Pipes (a collection of different lengths of cross-blown tubes) were considered in ancient Greece to be the province of shepherds or worse. Plato didn't want them in his Republic. When they are not producing truly celestial music with them, Hispanic countries relegate the instrument to *castrapuercas*. Your Spanish is correct; the instrument was used to signal the coming of the pig gelders and is still used by knife grinders. In ancient China, however, the instrument was elevated to the post of today's oboe player in a symphony orchestra, the purveyor of the note to which all other instruments must tune.

There is a Chinese legend in which the imperial standard pitch was lost. To replace it, the new emperor, Huang-Ti, upon consolidating his kingdom after years of war, sent his minister, Ling Lun, to the ultimate source of the correct tuning note: the tone produced by the Phoenix bird. After many travels the minister brought it back, having cut a length of bamboo to produce the exact pitch of the bird's note. Along the journey home he cut pieces of bamboo to create the relative pitches necessary to complete the rest of the scale. When he returned, the empire was not only able to tune with itself, but the whole country measured itself according to the length of bamboo necessary to produce that bird's note. That piece of bamboo became the new standard inch.

As fanciful as this whole story may seem, I remember a report of old field recordings of certain birds in China. When they were compared to the songs of modern birds, the recordings showed that they sang at the exact same pitches, not just the same songs, which have also been recorded.

In the Greek story of the origin of the instrument itself, a cloven-footed, double-horned being with a reputation for creating chaos in crowds (thus the word *pandemonium*), was pursuing an unwilling young damsel through bucolic countrysides with (in her mind, anyway) evil intent. The girl Syrinx's cries were heard by sympathetic water maidens as she tried to cross a brook with Pan in hot pursuit. They turned her into a bunch of tubular cane standing in the river. The wind blew across the tops of these metamorphosed reed plants and created the sound that Pan, running up quickly behind, claimed to be the very voice of his intended beloved. He then purportedly gathered the reeds tenderly together and sighed longingly across them, thereby creating her lovely voice again. At least the story is acoustically correct, as was the Chinese legend.

The principle here, in both cases, is that an air stream directed across the edge of a tube at an appropriate angle will create a tone whose pitch is governed by the length of the tube. This principle may be experienced by blowing across pen caps (*pen*-demonium?) perfume bottles, olive oil jars, pop bottles, blown eggs, and any tubular or globular form that has a narrow top and is closed at the bottom.

Pen caps and many other objects will play as pan pipes.

The common soda straw is a good material with which to produce a two octave set of pan pipes (also known as Syrinx in honor of Pan's melancholy maid).

Back in the days when my studio existed not on the proverbial shoestring but, indeed, on mere straws — soda straws, to be exact — I requested that my students pick up a few extra straws for me every time they went out for a hamburger and milkshake. I was overwhelmed but delighted with the great fistfuls of straws they gleefully brought to me still encased in their little white paper wrappers. The straws, too, were made of paper in those days. I developed the ability to make oboes from them, which will be dealt with later in this article. When plastic straws came out I had to deal with this new material, and the soda straw pan pipe is one of the instruments I developed for the plastic straws.

Most pan pipes of the raft type, that is, with the straws lined up in a row, are bound together with some type of cord and usually have one or two pieces of cane wound into the structure to keep it rigid while playing. According to Ovid's *Metamorphosis*, Pan connected his Syrinx reeds with wax. Another form is to make all of the tubes from clay, and forge connections between the tubes with the firing process fusing them all together. In both of these models, the tubes themselves have a certain thickness which separates one blowing area from the next even though the pipes themselves are bound together tightly. In a soda straw, the walls of the tube are so thin that if you put them next to each other with no spacing, there is not room for the mouth to produce an embouchure sufficient to produce a tone from each individual pipe.

One early solution I had to this was to place the straws between the spaces in pieces of plastic comb binding, such as you might find on the back of plastic comb-bound books. Realizing that this was not a material common to most homes, however, I kept searching. After awkward attempts to punch holes in cardboard strips to secure the tubes, I noticed a Styrofoam tray on my worktable. It had the most interesting design in its flat bottom: a

THE EMPEROR AND THE LOST NOTE

A Chinese Legend

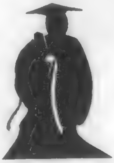
Retold and illustrated by Robin Goodfellow

A long, time ago in China, the flowery land, there were many wars and

even the plow horses were made to fight in battles.

The country was devastated. Pagodas were burned.

Finally, peace came to the land.

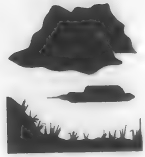


The great emperor, Huang Ti, united the country, but

was unable to tune his own orchestra because the standard pitch had been lost.

He sent his minister, Ling Lun, to find the lost pitch from the immortal Phoenix bird.

Ling Lun traveled over high mountain passes and



floated down long, slow rivers, lonely and discouraged.

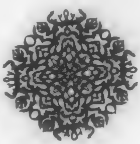
One morning he arose cold and cheerless and decided to turn back. Just at dawn as he turned to go,

he saw a feather drop from the sky.

The phoenix?

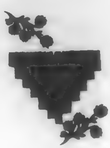
Yes, but to see a phoenix and to hear a phoenix are two different things.

The bird flew high into a tree and Ling Lun stood below and waited, and waited and waited. After a long, long, while,

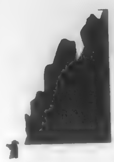


The Note!

Quickly, he cut a piece of bamboo to the length necessary to produce the note he heard.



All the way home he cut other pieces of bamboo to the appropriate lengths to make the rest of the scale.

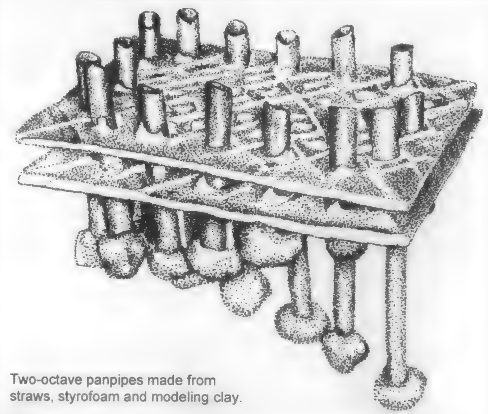


When he arrived back at the palace he had a complete set of pan pipes, with the notes of the female phoenix on the one side and the notes of the male phoenix the other. Now the orchestra could tune.

The orchestra tuned and the length of bamboo required to make the tuning pitch became the standard inch throughout the land. So the entire country tuned itself and measured itself to the note of a bird and the length of a pan pipe.

rectangle of diamond shapes with a dimple in each compartment. I cut this shape out of the tray with scissors, punched a row of quarter-inch holes along the outside edge with an ordinary quarter inch paper punch, and using the dimples as a guide, created holes around the periphery of the piece of Styrofoam. Even the extra-large diameter straws I was using fit in with no objection. I did the same with another tray (noticing the musical sound as the scrap pieces of tray struck each other as they were being discarded). The straws fit into the second tray, and were now stabilized for playing, being held firmly between the two trays. The straws were cut and the bottom of each one filled with children's colored modeling clay, thus providing the stopped end that is needed in order to produce the sound.

After the length of each straw had been cut, I fine-tuned them by forcing some of the modeling clay higher or lower inside the tube. If you make this instrument, be sure that the seal is complete and no air will escape from the bottom of the straw. My husband Charles says that he thinks bubble gum might do a better job of it, but I have not tried this yet.


Two-octave panpipes made from straws, styrofoam and modeling clay.

When playing pan pipes, I have noticed that blowing more directly downward into the tube facilitates the low notes and angling the air stream more across the top of the edge makes the high notes easier.* Also, I cut an angle on each straw to blow against, then cut the sharp point off to lie gently on the lip of the performer. This seems to make them easier to play. Lower notes may be produced from straws of wider diameter cut long. If you want to tune your pan pipes to other instruments, be sure to tune your first note to a standard pitch and then the others by ear or tuner as desired. (I completed a set, was pleased with its relative intonation, then took it to a keyboard to test and discovered that the whole instrument played exactly halfway between c and c#.)

A relevant story? The exasperated accompanist to the soprano: "Lady, I have played on the white keys; I have played on the black keys; but you are *singing* in the cracks!"

To teach rudimentary harmony with the pan pipes, use one color of pipe for the first, third and fifth straws, a second color for the second, fourth and sixth, and a third color for the seventh. This will allow rapid finding of the notes and establish a familiarity with the tonic chord and the leading tone.


The Sliding Straw Single Pipe.

Straw instruments lend themselves to becoming *sliding* straw instruments. This single sliding pipe is a simple, compact instrument with a range of about two octaves. Use a clear straw and look in a mirror while playing to watch the action of the plunger to get the idea of where the notes are. It doesn't take too long to get the hang of it. Try glissandos up and down, staccato and legato, and play for all occasions: Happy Birthday, Purcell fanfares, wolf whistles, and sirens. If desired, mark the straw off according to the pitch of the notes and the location of the inside plunger, which can be seen even through a translucent straw. Play with recorder groups or other instruments for a truly different, and not terribly reverent tone color.

Directions for making a sliding pipe (see illustrations, next page):

Take a plastic soda straw a quarter of an inch in diameter and a paper punch that is also a quarter of an inch in diameter. Hopefully the straw will be slightly smaller on the inside diameter than the punched-out hole.

You will need a small piece of thin plastic art foam (available at art stores), a pipe cleaner, a pair of wire cutters to cut the pipe cleaner if desired. (No, *no*, please do not use scissors to cut the wire in the pipe cleaner!) *Do* use scissors to cut the plastic straw. Obtain a small amount of olive oil. (Other oils may work also. Experiment.)

Punch three circles, one at a time, from the foam. Take one end of the pipe cleaner and, with a twisting motion, force it through the exact center of one of the small circles of foam. Push it down about a half inch, then force the next one on in the same manner, and finally the third.

One good brand of straws for this purpose is "Stay-Bent" by Winkler Flexible products. Another is a milk straw by Sweetheart.

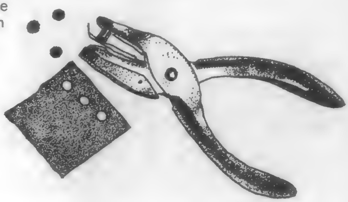
If using the "Stay-Bent", cut the end of the straw off just below the flexible part at a slight angle. If the straw has a point where you cut it, trim a tiny bit off to make it slightly rounded. Test the straw by closing the bottom with your finger and blowing across the part you cut off, with the high part resting on your lip and the air stream directed at the opposite edge, as if playing a pop bottle. If you don't get a tone right away, make sure that your finger is closing the bottom completely. Also, the length might be too great for the diameter of the straw. Chop off the bottom of the straw and try again. Try changing the angle at which you blow. Aim the air stream across the straw to the opposite edge. Try many positions until you can get a good, strong tone each time you pick

*To play some instruments, such as the turkey baster made suddenly popular by Franck Sunseri of Monterey, California, the low notes are produced by barely touching the instrunment. Large jugs in vaudeville jug bands were played by rapidly expelling air in a "phh" style over the jug, directly into the opening. Thus deeper tones are produceable than would be possible with a traditional flute-type embouchure. To play the rest of the notes on a turkey baster, fill with water and blow across the small open end. Squeeze the bulb to force the water to change the dimensions of the inner champer, producing dirreent notes.

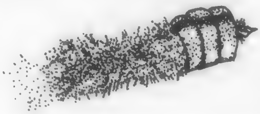
MAKING A SLIDING PAN PIPE

(see the main text for full instructions)

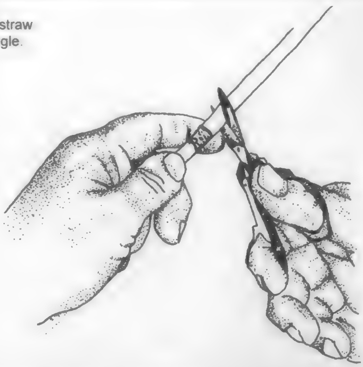
Punch three circles from the foam.



Push the pipe cleaner through the center of the three circles.



Cut the straw at an angle.



First cut an angle, then trim the top edge for comfort.

Try different ways of blowing.

Change the angle of the straw and the position of your lips until you get a good tone.

Straw in bottle instrument

it up. This might take some practice if you are not used to playing flutes, or the aforementioned pop bottles, perfume bottles or pen caps.

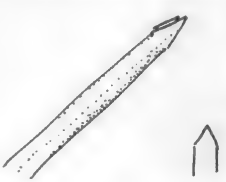
When you can get a good tone whenever you want it, force the pipe cleaner with the three circles into the bottom of the straw. Now take the olive oil and pour about three drops in through the top of the instrument . Work the slide up and down a few times until it slides smoothly and blow across the top. You now have a completely portable, very inexpensive instrument for parties, long hikes, ensemble playing and solo recreation. It will play in any key (even in the cracks), and in any scale, some of them previously unexplored or possibly unintended.

A very simple variation on this instrument is to take an angle-cut straw and place it in a narrow-mouth bottle filled with water. The level of the water should be nearly as high as the length of the straw. Push the straw in and out of the water as you play, or push the bottle up and down as you play. Watch this in a mirror as you play in a clear bottle. The initial pitch changes for each note become understandable this way. Also it is entertaining to watch inside the straw as the water adjusts to the differing air pressure and seeks its own level. A cup or wider-mouthed water container will have more pitch variation. Experiment. Of course, just blowing into the water with the straw is a sound effect not to be ignored. Use with fish songs and sea chanteys.

When I first started making straw instruments, straws were made of paper. These made excellent oboes — that is, soda straw instruments played not as edge-blown flutes, but through an oboe-like double-reed arrangement made by slitting and trimming the end of the straw a certain way. When the industry changed to plastic, I bought out the local restaurant supply house, taking the last of their paper straws, but the change was inevitable. Plastic straws were here to stay. To accommodate the new material, I developed the plastic straw proto-clarinet instrument featured in my article "Laudable Launeddas and Other Reedy Folk" in the previous issue of *EMI*. This was a soda-straw instrument using a clarinet-like single-reed configuration. But with the paper straws I had previously used for making the double-reeded oboes no longer available, I was still missing the oboe from my straw orchestra, so I started making the oboes from plastic straws. It takes a *lot* more pressure to play a plastic oboe than a paper one, but by changing the angle of the cut for the reed, I found I could make them playable.

Cut a straw as in the diagram. Note the difference between the plastic and the paper reed shape. Say "mamamama" with your lips exaggeratedly pulled back over your teeth. Put your lips, not your teeth over the reed. Place them near the bottom of the reed, press with your lips, firmly, very firmly, but not in a way that will stop the vibrations. Now blow with a great deal of pressure. If there is no sound, change the position of your lips, blow harder, press harder or less hard with your lips, or if nothing works, recut the reed. This will automatically transpose everything a bit higher, but anything to get the sound! The paper straws were able to render nice scales. It is more difficult to get a plastic straw to play a recognizable scale, but I think it can be done. Pinch the straw an inch or so from the bottom and punch a half circle. Make one finger hole at a time starting at the bottom and going up. Test the results of each one as you go along.

Double-reed cut on a paper straw



Doulbe-reed cut on a plastic straw

Fran Holland, of Berkeley, California, invents instruments and shares his designs with children He has developed several ways of amplifying he sound so straw oboes. A simple way is to roll a piece of paper (he gets misprinted posters free) into a cone shape with a small opening into which he places the straw reed and tapes it all together. A second piece of paper may be added to the bottom of the first, increasing the size of the cone and the obnoxiousness of the instrument. (Practice this before doing it with kids. It is a little tricky to get just the right size hole for the straw. Fran suggests starting at one corner, and rolling loosely, not too tight at the beginning, then tightening later. I am still practicing to get a perfect roll.) Fran also has a better way to cut the holes in the plastic straws. Bend the straw where you want the hole to be, and cut the corner off with scissors. This is easier than punching and requires one less tool for the project.

One of Fran Holland's students playing an amplified straw oboe

So here is a set of pan pipes, a slide whistle, and an oboe to be made of straws. I wish there were many more issues of *EMI* to explore further the straws, yogurt cartons and other materials for instrument making. I have enjoyed working with the editor Bart Hopkin and producing illustrations and articles for these last twelve years. I will miss *EMI* and I'm very, very glad that I have a complete collection of magazines from the beginning for my own reference.

Fran himself playing a straw reed put into a piece of cane found while hiking in the woods. He pierced holes with the only available tool, his car keys. He found a piece of wire and attached the printed trail guide for a resonator bell and added some pine needles for a flashy ornament that makes a swishing sound when he waves the instrument as he plays.

Fran uses tubes, funnels, plastic bottles and used thread holder cones, among other things, as resonators for his straws. They can sound as loud as a saxophone being attacked by elephants. Kids love them.

FOR FURTHER REFERENCE

The New Grove Dictionary of Musical Instruments, in three volumes. Stanley Sadie, ed. Macmillan Press Limited, London, 1984.

The article on playing the turkey baster appeared in *Monterey County Herald*, Dec 31, 1998 (PO Box 271, Monterey, CA 93940).

A different version of the phoenix story may be found in: *Musics of Many Cultures: An Introduction*. Elizabeth May, editor; forward by Mantle Hood. University of California Press, Berkeley, Los Angeles, London, 1980.

Fran Holland may be reached for performances or workshops at (510) 525-0697, 1322 Martin Luther King Drive, Berkeley, CA 94709; email franmary@lmi.net.

Robin Goodfellow is the director of Mandala Fluteworks, a studio of music and art in Oakland, California. She has been teaching children and adults for many years, and plays flute, piccolo and tin whistle among other instruments. She is the original founder of the Queen's Ha'Penny Consort, a recorder and early instrument group that specializes in the performance of Renaissance music. Robin draws from her extensive collection of musical instruments to provide illustrations and articles for EMI, where she has been a regular contributor for a dozen years.

Robin can be reached at 1655 Vista Street, Oakland CA 94602, by phone (510)530-7835 or by email at robingoodfellow@earthling.net.

EXTRA, EXTRA — STROH VIOLINS STILL BEING MADE!!!

By Cary Clements

During the first quarter of the twentieth century, sound recordings were made using wax as a medium. The needle that cut the groove in the wax, where the recorded sound was stored, was powered only by the acoustical energy of the source being recorded. Under these conditions, violins played in an ensemble could only be effectively recorded using a specially designed violin. This unique violin would focus the output of the instrument into the recording horn that was used to gather sound in the recording process. Invented by Augustus Stroh, who was a pioneer in the development of sound recording, it was called the Stroh violin.

Stroh violins were made by the Stroviol company of London from 1901 to 1943. Due to advances in technology, they were no longer used for recording purposes after the mid 1920s. Their continued popularity was probably due to the fact that they were loud. In the days before electric instruments or public address systems, this could be useful to a musician playing with other loud instruments.

From the time it was invented, Augustus Stroh's violin design inspired many copies, some of which were patented in the United States. For more information about these instruments, read the article entitled "Historical Patents for Horned Violins" in the December 1997 issue of *EMI* (Volume 13, #2). Even today, more than 50 years after the original Stroh violin went out of production, Stroh-inspired violins are still being made!

After the publication of my article "Augustus Stroh and the Famous Stroh Violin" in the June 1995 issue of *EMI* (Volume 10, #4), I received a letter from Craig Packard of Maryland, informing me of the use of a Stroh style violin in Transylvanian dance music. About the same time, I read a newsgroup posting on the internet describing a weird violin that was made in Burma. I tried to get pictures of these two instruments at the time, but alas I could not.

However, I recently received two different sets of photographs. Both arrived as the result of many phone calls, letters, and emails sent over the course of a few years. And both greatly excited me.

The first arrived via the US Postal Service from Santa Cruz, California sent by Paul Rangell. These showed various views of a Stroh violin that he had bought while on vacation in Burma. The rumor that I'd heard about the existence of a Burmese-made Stroh violin was finally proven to be true.

The Burmese Stroh violin is a crude but credible copy of the original Stroh violin. To make this instrument, an original Stroh was copied almost detail for detail. The instrument differs from a London-made Stroh violin in many ways. Various parts that on the original are aluminum and wood, on the Burmese copy are made with brass. And some parts are just not shaped the same — the big horn and the monitor horn, for example. The diaphragm housing is bulkier than the aluminum original. It's hard to put into words how exactly they differ. Let's put it this way — when I look at a picture of an original Stroh I see a graceful elegant design. When I look at the Burmese Stroh I see a crude, cheesy copy. But it's a cool-looking cheesy copy nonetheless.

There's a lot of brass on this instrument. The diaphragm housing, amplifier horn, bridge assembly including the connecting arm, the monitor horn are all made of brass instead of aluminum. Even the tailpiece, third position stop, chin rest and tuning machines are made out of brass. The body and neck are made of a light-colored wood stained dark brown to resemble mahogany. The fingerboard is also a light-colored piece of wood, but painted gloss black to look like ebony. The diaphragm appears to be made of aluminum. The bridge is a regular maple violin bridge.

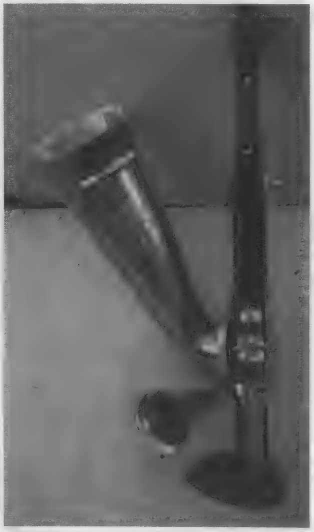
I was very curious as to why the Stroh violin, in a form very close to the original, was still being made in, of all places, Burma. I called Rick Heizman of San Francisco with some questions about Burmese music, and the role of the Stroh violin within that. Rick knows quite a bit about Burmese music and culture, having traveled to Burma many times in the past few years. He has recorded many of the best musicians in Burma, resulting in a series of CDs for Shanachie produced by himself. The first of the series, *White Elephants & Golden Ducks — Enchanting Musical Treasures from Burma* was released in 1997, and reviewed by Bart Hopkin in the December 1997 issue of *EMI* (Volume 13, #2).

Rick was aware of the Stroh violin, but really didn't have any answers. However, he was about to make another trip to Burma to attend a music festival. On his return we talked, and he told me that he had asked around about the Stroh violin among the musicians, but nobody knew anybody that played one.

Hmm. They make them there, but they don't play them. Rick suggested that perhaps they were being made as souvenirs to be sold to tourists. That's the most plausible theory we could come up with. As to why in Burma of all places, the two reasons that first come to mind are that Burma was a British colony, and the Stroh violin was a British made instrument.

The second set of photos I received arrived on my computer screen a few months later via the internet. I had arranged for my brother Chris to go to the home of Richard Morrison in Kensington, Maryland to take pictures of his Transylvanian horned violin. The only camera he could take with him that day was a digital one, and he was able to email me the results. As I opened the first photo file I was pleased and surprised to see how bizarre and beautiful this instrument was.

The Hungarian name for the horned violin is *tölcseri hegedü*, which literally means funnel fiddle. They are also called bugle



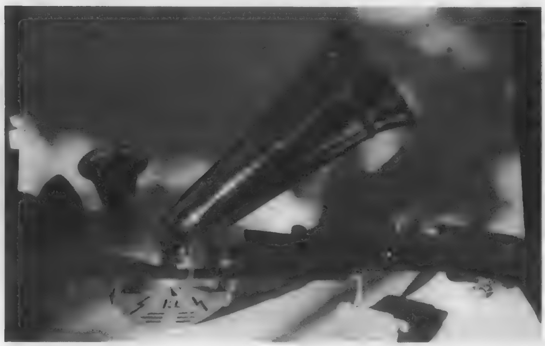
BURMESE STROH VIOLIN

Upper left: Front view of the Burmese Stroh violin. All the same parts are there, it's just a little awkward and clunky when compared to the original Stroh violin.

Lower left: Rear view of the Burmese Stroh violin. The amplifying horn and the monitor horn have been removed. Note the use of tuning gears on the side of the scroll/peg box instead of friction pegs.

Upper right: Paul Rangell playing his Burmese Stroh violin. The sound waves coming from the horn just blasted another hub cap from the fence. Just kidding!

Lower right: Side view of the Burmese Stroh violin. The diaphragm is covered by a protective grill that attaches to the circular housing. The two horns, tuning gears, tailpiece, diaphragm housing, third position stop, and the bridge support assembly are all made of brass.



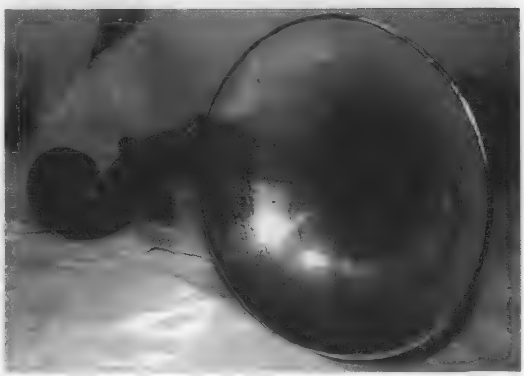
fiddles. The Transylvanian funnel fiddle is most definitely not a copy of the original Stroh violin. The fundamental difference between the two are the mechanisms that transmits string vibration from the bridge to the diaphragm. On the original Stroh violin, the bridge sits on a platform that pivots on a centrally located knife edge. A rigid arm attached to the platform transmits string vibration to the center of the diaphragm.

On the funnel fiddle though, one foot of the bridge rests on a small pin that is firmly attached to the body of the instrument. The other foot sits on a rod that somehow attaches to the center of an aluminum diaphragm. I say "somehow attaches" because I'm not really sure exactly how it does. I called Richard after I got the photos to see if we could figure out how it connects, but we couldn't. And I didn't feel comfortable asking him to take his instrument apart, so . . . the important part was that I had photos.

The funnel or bugle fiddle is a very stylish-looking instrument. The narrow body is carved from a single piece of light-colored wood, including the circular hump below the bridge that houses the aluminum diaphragm. The chin rest and shoulder rest are carved from a single piece of wood, and then glued to the tail end of the body. The instrument has been stained with a brown varnish.

The neck of the funnel fiddle is a regular violin neck, with a scroll and friction pegs. It was made separately, and then attached to the body. The horn is long and narrow, and probably made of brass that has been chrome plated. A metal arm attached to the middle of the horn is screwed to the back of the body near the neck joint. This helps to stabilize the horn.

The funnel fiddle, though, is not made as a trinket for the tourists, but is built to be used by local musicians in Transylvania. The following quotes from the book *Romanian Folk Music* by Tiberiu Alexandru[1] might help



TRANSYLVANIAN FUNNEL FIDDLE — photos these two pages

This page,top: Richard Morrison playing his bugle fiddle. Note the stabilizing arm that connects the horn to the body.

This page, middle: Side view of the bugle fiddle. The round hump below the bridge is actually carved from the same piece of wood that the rest of the body is made from.

This page, bottom: The bell of the horn and the scroll of the Transylvanian bugle fiddle. The horn appears to be made of chrome: plated brass.

Next page, top left: Bottom view of the bugle fiddle. The shoulder/chin rest at the tail end of the instrument is made from a separate piece of wood and then glued to the body.

Next page, top right: Front view of the bugle fiddle or funnel fiddle. The perforated disc below the bridge is the cover plate for the diaphragm.

Next page, middle: Tail-end view of the bugle fiddle. This violin uses an end pin, saddle, and tail gut to hold the tail piece in place. The chin/shoulder rest mimics the body of a traditional violin.

Next page, bottom: Side view of the bugle fiddle. The bass foot of the maple bridge rests on a pin anchored to the body. The treble foot sits on an arm that attaches to the diaphragm. Note how far the strings are from the fingerboard, and how close the fingerboard is to the body. I believe this condition is the result of the body being very thin underneath the unattached part of the fingerboard.

explain some of the history of this instrument. Mr. Alexandru is a well known and serious Romanian scholar.

"The specific tone-colour of traditional violin music is a result of the development of certain procedures proper to folklore, generally ignored by cultivated professional practice.

"During the inter-War period a curious kind of violin began to spread in the country, with a metal horn, or even two, instead of a sound-box, with its bridge supported on a mica membrane. The vibrations of the strings, transmitted to the membrane, are amplified by the bell. A penetrating, somewhat metallic sound results. Originally it was a factory-made instrument (the 'Tiebel-Radio system violin'[2], like the 'Stroh violin' in England and America) which the lautari call *vioara cu goarna* or *vioara cu corn*, or *lauta cu tolcer* (bugle-fiddle, horn-fiddle). Nowadays, they make the instrument for themselves. Fiddles of this kind have been found in the Nasaud, Mures, and Bihor districts of Transylvania. In the Banat, in Sichevita, the lauta cu tolcer has three strings."

Another quote from *Romanian Folk Music* sheds some light on the above passage:

"Occupational players, full-time or part-time professionals, commonly called lautari, play an important part in the musical life of the folk. As we have seen, they play at various feasts and on other occasions. Ballads, wedding songs, and particularly dances are performed by them in most parts of the country.

"The lautari change both their repertoire and their performance manner, also the instruments they handle, according to the tastes of their listeners. Both repertoire and performance manner are the same at any given place or time, whether the lautari are gypsies (as most are), Romanians, or players of other origin. The most typical lautar formations, one might call them 'classic', comprise violin and cobza[3]; violin and portable cimbalom[4]; violins and double-bass; violins, cimbalom and double-bass; violin, accompanying violin and double-bass; violins, clarinet, cimbalom and double-bass, etc."

I must admit that I know very little about Transylvanian music. One feature of the music is the use of what is called "contra". Contra utilizes a 3-string violin that has a flattened bridge which enables all three strings to be bowed at once. Bowed three-note chords supply rhythmic drive and chordal support for dance music. The contra player hardly ever plays any melody lines.

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1. *Romanian Folk Music* by Tiberiu Alexandru, Musical Publishing House, Bucuresti, Romania, 1980. Translated by Constantin Stihi-Boos. Translation revised by A.L. Lloyd [the famous, knowledgeable, and prolific British collector and scholar of folk music]. pp. 105, 107-108.

2. The Tiebel violin was a German-made copy of the Stroh violin.

3. A cobza is a folk lute.

4. A cimbalom is a close relative of the hammered dulcimer.

To hear some of this music, I bought a CD entitled *The Edge of the Forest — Romanian Music from Transylvania* on the Music of the World label. There's a photo on the cover that shows a man playing a bugle fiddle. A close reading of the liner notes though, does not reveal whether or not one is being played on any of the tracks. Craig Packard tells me that the funnel fiddle is usually used for dance music because it can be heard over the other instruments, and the general commotion of the dance floor.

Looking at the photographs of these two instruments I couldn't help but make a few observations based on my experiences working on guitars and violins. One thing that is important to a violin player is having an instrument that is light in weight. The traditional wood violin usually weighs 16 ounces or less. The one time I actually held an original Stroh violin it felt a little heavier than a wood violin, and the horn made the balance a little awkward. But it was quite playable. Seeing all that brass on the Burmese Stroh violin makes me think that it must be quite heavy for a violin, and therefore a bit uncomfortable to play.

I also noticed that the rod that connects the bridge arm to the center of the diaphragm was crooked. Repositioning the diaphragm housing on the body would correct this situation. Remember, I've never seen these instruments in person, only seen pictures.

The observation I can make about the funnel fiddle has to do with the size of the body between the bridge and the neck joint. The body is very thin at this point, and looks like it has bent under the string tension resulting in a lower bridge height and higher string action. My home made Stroh violin is very thin in the same region, and has also started to bend.

I'm certain the funnel fiddle was made by people well versed in violin making. Every detail looks well thought out. The body and neck were probably made in a production shop by violin luthiers, and the horn made in a brass instrument shop. The diaphragm and cover plate look like they were stamped out on a punch press.

I still have a lot of questions about these two violins. I really do wish I knew more about the shops they were made in, the crafts people that made them, and how they came to be made in the first place. I also think they aren't the only examples of Stroh-inspired instruments out there. They just happen to be the two I know about. In any case, one hundred years after its birth, Augustus Stroh's violin lives on!

Many thanks to the following people for their help in the preparation of this article: Craig Packard, Chris Clements, Richard Morrison, Rick Heizman, Paul Rangell. . . and eternal gratitude to Bart Hopkin and *Experimental Musical Instruments*.

Cary Clements is fascinated with the Stroh violin but has only seen two in his lifetime. He'd like to get his hands on an original example, but they are an elusive breed. . . He can be contacted at 4 Curtis St-2nd floor, Lewiston, ME 04240, telephone: 207-777-5201, email: Cary_Clements@onf.com (don't forget the underline between the two names).

RECORDINGS

From the editor: Originally we had not intended to included a recordings reviews section in this last issue of *Experimental Musical Instruments*, the issue being so crowded with other things. But one of our reviewers, René van Peer, came forward with a last-issue theme piece: a thought-provoker about the nature of the medium, in the form of an essay-review on four selected, conceptually related recordings. Our reviewer Mitchell Clark, too, sent along one last piece. Their writings follow here.

THE EVOLUTION CONTROL COMMITTEE:
COMPACT DISCTRUCTIONS

On cassette from ECC. PO Box 10391, Columbus, OH 43201 (e-mail: ecc@pobox.com)

RAFAEL TORAL/PAULO FELICIANO:
THE COMPLETE NO NOISE REDUCTION

On CD from Moneyland Record$. PO Box 30036, 1321 Lisbon codex, Portugal

IOS SMOLDERS: **MUSIC FOR CD-PLAYER**

On CD (Staaltape CD 077) from Staalplaat, PO Box 11453, 1001 GL Amsterdam, Netherlands (email: staal@euronet.nl). Distributed in the USA by Soleilmoon, Portland, Oregon.

PAUL DEMARINIS: **THE EDISON EFFECT, A LISTENER'S COMPANION**

On CD (Apollo Records ACD 039514) from Het Apollohuis, Tongelresestraat 81, 5613 HW Eindhoven, Netherlands. Distributed in the USA by Forced Exposure.

The delusion of sound equipment manufacture is that the product will reproduce sound as it was once captured. Most people don't give that a second thought. They listen to records and live perfectly normal lives (or not, as the case may be). There are others who do give that conception some thought, conclude that it is untenable and focus on ways in which it may be subverted or blown up. These four albums all do that in some way or other.

Compact Disctructions by the Evolution Control Committee, headed by (or maybe exclusively composed of) Mark Gunderson, takes the shape of a recorded demonstration lecture about methods to make CDs behave aberrantly. The dogma getting subverted here is that digital technology and the way data are stored on the disc's surface make these products impervious to "hands on" processing similar to what tape and vinyl can be subjected to. The CDs played in the presentation have been warped with a blowtorch, decorated with a black marker pen, and hammered on; another demonstrated method is tilting the player in the procedure. Gunderson calls the pieces he plays from the prepared CDs compositions. That, I think, is a bit of an exaggeration in most cases. The sterile stutterings and rebounds, the unequal length of the sequences you get to hear are more fun to listen to as the result of subversive tampering than as autonomous musical pieces. But he does show that his actions may turn CDs into excellent source material for music — and satire. The tape comes with an extensive manual and a try-it-yourself CD. Kids are invited to do this at home.

In a sense the Portuguese duo Paulo Feliciano and Rafael Toral put Gunderson's concept and attitude cheerfully into musical practice. They use just about any object associated with pop culture as their instruments. As is stated in one of the pieces, they have "borrowed from everyone else's universe." The forty-six tracks, ranging from zero seconds (it is cued in as such) to an

exceptionally long 4' 45", defy any description that would attempt to do justice to the variety in approaches and sounds resulting from them, and to the wit and the humor with which this album has been put together. A few scant examples should suffice. Toral and Feliciano realized a piece that everyone whose musical awareness predates the digital era must have fantasized about: glue the halves of a broken record together so that the playing area has a side A and a side B component, then play the record. On another cut, *Groove Grinder*, they play scratchy runout grooves. They make some heavenly sounds with tones of a music box played with serious warpage from a sampler and a sustain guitar. They rebound the whish and whoosh from an amplified spring coil by wringing it back and forth through a sampler, and entitle that in poetical jest *Sonic Spring*. This work is nothing short of inspired. The shining new wheelbarrow pictured on the cover illustrates what may well be their motto: "The tools you use are just as pure and clean as the use you put them to."

The humor on Ios Smolders' *Music for CD-player* is slightly more dry. He has recorded, processed and mixed sounds coming from his home stereo and television set — in other words, sounds as they might surround a person in an average living room. These sounds may be anything, from albums Smolders played (including those he made himself, I imagine) to programs on TV, to a viciously strong hum resulting from bad grounding. In fact there is special attention to sounds generated by the imperfection of equipment — scratches, clicks, hiss. Sometimes several layers of scratching are mixed together, one directly in the foreground, another further away. Composing and assembling this CD must have been a maddeningly painstaking job — so many snippets and fragments put together, longer sequences shredded and then scattered about. It is an achievement that he has managed to shape these ingredients into one coherent composition. His next step, however, has been to subvert that by dividing the CD into 99 cuts. Transitions from one to the next are sometimes obvious, sometimes decidedly less so. The trick is that by reprogramming the CD-player, by using shuffle mode, or by preparing the CD, the listener can make each rendition of the basic material a new musical experience. My own player didn't think this was at all funny, spewing out Smolders' wonderful extravaganza after having played in shuffle mode for some time.

Paul DeMarinis' CD, conceived as an audio companion to his mid-1990s multimedia project *The Edison Effect*, also makes use of the latitude offered by imperfections of sound equipment, from the phonograph cylinder to digital synthesis and reproduction systems. Thematically it is rather more complex than the other albums discussed here — in part because on this CD DeMarinis overlays old recordings with sounds generated through tools of more recent technology, resulting in rebounds between them and superimposed reflections. The interpenetrability of sound layers creates convincing symbiotic pieces, hybrid sound creations. The first cut, for instance, consists of the first word ever to be recorded ("Mary", spoken by Edison) digitally expanded to the length of a wax cylinder, two minutes. Other tracks take as a starting point that stylus-type recording mechanisms etch sounds onto a rotating surface through vibrations they pick up — it doesn't matter whether the surface is Mesopotamian clay pottery having been decorated on the wheel by running a twig along it with sounds from livestock and conversations close by, or whether it's a blank wax roll on which DeMarinis has recorded the sounds of the phonograph mechanism in several superimposed takes.

Through a judicious use of the various technologies DeMarinis reveals sonic qualities that had until then lain hidden in them. This points to one of the threads running through this album — in this day and age alchemy (the pursuit of knowledge of the natural and the supernatural combined) is as alive as it was in the Middle Ages. One of the tenets you may typically hear vented by advocates of digital technology is that it changes people, moving our species forward, on to a higher rung on the ladder of evolution. These latter day apostles should examine the phantoms in the mirror DeMarinis holds up for them — it might bring home reality to them with something of a shock.

— *RvP*

MOHAMMAD RAHIM KHUSHNAWAZ:
AFGHANISTAN — THE RUBÂB OF HERAT

VDE-Gallo (Switzerland) CD-699

I want to thank René van Peer for bringing this recording to my attention, in his recent letter to *EMI* (vol.14, #3). In that letter, René commented on my review of the recording *Live with the Birds* (*EMI*, vol.14, #2), by the Maciunas Ensemble and the Kanary Grand Band (Apollo Records). René corrected a misunderstandng of mine concerning the nature of the Maciunas Ensemble's instruments (their use of aluminum strips rather than aluminum wires) and expanded upon my review to further discuss the work of the Maciunas Ensemble, as well as additional instances of the musical interactions of birds and humans. It was in this context which he mentioned *The rubâb of Herat*.

Originally recorded by John Baily in 1974, *The rubâb of Herat* features Mohammad Rahim Khushnawaz, the Afghani master of the *rubâb* lute, at what was, in Baily's estimation, the height of his career. The album's thirteen selections include Mohammad Rahim's performances of both the traditional music of Herat (in western Afghanistan, near Iran) and the instrumental art music of Kabul (Afghanistan's capital, in the east, near Pakistan). Many of Rahim's performances here are accompanied by his brother, Mohammad Naim Khushnawaz, who plays *tabla*. And a few of these performances are further augmented by the presence of two caged canaries.

In the first and longest of the tracks on which the canaries are present, *Chahârbeiti Siâhmu wa Jalâli/Âmine/Aushari* from the Herat repertoire, the canaries may be faintly heard in the background for much of the performance. However, they burst into brilliant song as Rahim's performance reaches a climax. The effect is astounding. Additional performances of the Herat repertoire and one of the Kabul repertoire are also graced by the canaries' singing presence.

After hearing these recordings, I ran across a reference in a modern edition of *The Bird Fancyer's Delight* (an 18th-century manual for teaching tunes to song birds) which described a sparrow which would sing whenever it heard running water or a piano. I was reminded of a parakeet I had as a teenager who reacted very strongly whenever he heard music, live or recorded. He squawked very fiercely, which I assumed at the time was displeasure. But perhaps he was quite happy.

In *The rubâb of Herat*, the canaries are a welcome and beautiful presence in these superlative performances by Mohammad Rahim Khushnawaz. I appreciate René's introduction to this recording, as well as his comments on *Live with the Birds*.

— *MC*

Maker of Slap-A-Phones, Jeff Fahringer is still in business. Those who bought Slap-A-Phones from the now defunct Mandala percussion catalog, may now order direct. Not familiar with a big, beautifully crafted percussion aerophone? Just ask to be emailed a photo and sound clip. Dealer inquiries welcome. email: joffrey@ptd.net; 619 Leonard Lane, Tobyhanna PA 18466; Phone: (570) 894-1689

MANY AXES, the new CD by Susan Rawcliffe, is now available. Bart Hopkin says: "This is the first recording to do justice to those (Susan Rawcliffe's) instruments and it's a real pleasure to hear...." $15 plus $2 S&H. PO Box 924 San Pedro, CA 90733, e-mail SoundWorks@aol.com.

MUSIC EXPLORIUM seeks makers of creative and unusual musical instruments. A new retail store in NC specializes in instruments that are easy and satisfying for anyone to play. Prefer pitched instruments to be compatible with concert pitch. Wholesale terms and (reasonably) reliable production desired. Music Explorium, 5317 Pelham Road, Durham NC 27713; 919-544-5451; Blaiseon@intrex.net

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Looking for a toy piano! If you know where to get a used one for an affordable price, please contact Jonathan Chang (aka zHANg) at 447 8th, #405, Oakland, CA 94607.

BE the Instrument!! Mouth Music Press is your source for mouth resonated instruments and related recordings. We carry an international selection of Trumps, Clackamores and recordings, including the North American Jew's Harp Festival 1997 Highlights CD. PO Box 6444 - Boise ID 83707 USA. Credit Card orders: 208-338-1577 (9am-9pm MST) - www.mouthmusic.com [14-3]

Aloha EMI People: I am exploring possibilities of liquidating my instrument business including the Waterphone. I am open to different types of arrangements including partnerships or outright buy-out with the option of my acting in research and development capacity. I have been developing some of these designs for 30 years. Besides the various models of Waterphones I have about another dozen sound devices and instruments that could or could not be included. This sale would include all printed material, brochures, demo masters, special tools and web site. Interested parties should have (1) some capital (2) a willingness to organize and run a musical instrument business. Someone with marketing skills would be an asset. Upon agreement and a signed contract I will turn over all information and details about how to prepare, assemble and tune the Waterphones and other instruments. The potential is here but it takes one or more people that can do justice to the Waterphone in terms of getting it out to the buying public. As I have been approaching my instrument business more as an artist it is now time regroup as a business. If you are interested and would like to discuss this please contact me preferably by e-mail. Phone is OK if you call early as we get up at 6 (Hawai'i time.) and go down just after sunset. Otherwise you risk the chance of reaching my phone message. I don't have a financial figure set as it depends on many factors but I am willing to negotiate. I can be reached as >Bamboomuse@aol.com<or by phone at 808-965-0955 or you can write me at p. o. box 1071, Pahoa, Hawai'i 96778 U.S.A. If you have internet capabilities you can view many of my instruments on the web at >http://www.spacebeat.com/waterphone<I look forward to hearing from you. Mahalo, Richard Waters [14-3]

SURBAHAR (Bass Sitar) - Inlaid, carved mahogany & rosewood. Concert quality w/ case. $2500. Stephan 503-435-1131. [14-3]

Various **published booklets** on the **Jew's Harp** in English @ $3.50 ea plus shipping.To order, contact: (Foundation) Stichting Antro Podium, Bellinkstraat 7, 4331 GV - Middelburg, The Netherlands.

"Three Bags Full" new CD by PETER WHITEHEAD now available. A compilation of scores for film and dance performances all composed using original instruments featured in *EMI*. Send $15 to Strange Attractor Records, 455A Valencia Street, San Francisco CA 94103. (Includes shipping.)

Earthshaking Music Catalog is available (FREE!). Nearly 1000 cd, book and video titles of the best in world music. New shipments of instruments from Africa, India, Bolivia. Visit us in Atlanta at our new store, or on-line at www.earthshakingmusic.com. Email erthshkn@avana.net or call 404-622-0707. [14-1]

Dr. Guy Grant has started the Oddmusic e-mail list for anyone interested in experimental, ethnic and unusual music and instruments. To subscribe to this free list go to the Onelist Main Page at http://www.onelist.com and enter the name of the list you wish to join (Oddmusic). [14-1]

Send your $20 check to: DWIN, 6971 Rooks Ct., Frederick MD, 21703. You get color pictures plus cassette of sounds of many DWINSTRUMENTS (see "Browsing" article in the Sept '98 issue of EMI). I trust YOU, you trust ME. What a concept! [14-1]

BOOK AND CD: **Wisdom of the Impulse: On the Nature of Musical Free Improvisation**, a new book by Tom Nunn, and **Peering Over**: The Edgewater Experimental Instruments Consort, a new CD featuring 15 of Nunn's instruments with 15 players in live performance. $30 + $5 shipping for the book; $10 + $2 shipping for the CD. Payable to Tom Nunn, 3016 25th St., San Francisco, CA 94110. [13-4]

Seeking information: If you have information about bamboo saxes, or other sorts of unusual sax-like instruments, builders, history, references, anywhere in the world, please contact Ángel Sampedro del Río, Scalabrini Ortiz 1960, Villa Adelina (1607), Buenos Aires, Argentina, fax [international code, plus] 541-794-3880; email bambu@arnet.com.ar [14-1]

Reed Ghazala's **Anti-Theory Workshop** is now offering circuit-bent Incantors, Trigons, Photon Clarinets, Morphiums, Aleatrons, one-of-a-kinds, CDs and collected writings. For Reed's full-color, visually stunning brochure/catalog/fractal artwork depicting 18 instruments, CDs, friendly raccoons and more, please send $1 (or any interesting tidbit of your choice) to: Reed Ghazala c/o **The Anti-Theory Workshop**, Sound Theater, 3325 South Woodmont Ave. Cinti., OH 45213. Present web: http://www.iac.net:80/~cage/reed.html. Coming soon: http://www.anti-theory.com E-mail: qrg@anti-theory.com

Musical Instrument Design: Information for Instrument Making, by Bart Hopkin, editor of *Experimental Musical Instruments*, published by See Sharp Press. *Musical Instrument Design* presents underlying principles for the design and construction of acoustic musical instruments of all sorts, with a practical, hands-on approach. No other book gathers this information under one cover. Just under 200 pages long; large format; fully illustrated. $18.95 plus $2 s&h. (This covers shipping charges for U.S. air mail or overseas surface rate; for overseas air add another 25%. Customers in California add 7.25% sales tax.). Order from *Experimental Musical Instruments*, PO Box 784, Nicasio, CA 94946, USA, phone/fax (415) 662-2182, email EMI@windworld.com.

NEW from Experimental Musical Instruments and Ellipsis Arts: ***Orbitones, Spoon Harps and Bellowphones***, a book&CD compilation featuring the work of sixteen of today's most creative musical instrument makers. Each artist has one track on the CD, augmented by beautiful photos and informative text in the accompanying hardbound, 96-page book. This book&CD set is designed as a follow-up to *Gravikords, Whirlies & Pyrophones*, released by Ellipsis Arts just under two years ago and widely acclaimed. The format for the new release is smaller (comparable in size to a standard CD case, except that the hardbound book makes it fatter); containing fewer artists and selling at a lower price. Simultaneously, an abridged version of the original *Gravikords* set has been released in the

same smaller format -- see the following ad for details. Price for either the new *Orbitones* collection or the small-format re-release of *Gravikords*: $19.95 for book and CD. No shipping charges for U.S. air mail or overseas surface rate; add 25% for overseas air; California residents only add 7.25% sales tax. Available from EMI at PO Box 784, Nicasio, CA 94946, USA; phone/fax (415) 662-2182; email EMI@windworld.com Visa & Mastercard accepted.

GRAVIKORDS, WHIRLIES AND PYROPHONES --book-and-CD set from *Experimental Musical Instruments*, produced in conjunction with Ellipsis Arts publishing company. Devoted to new and unusual musical instruments from some of the world's most interesting and inventive instrument makers. Informative text, wonderful photographs and great recordings. Every track of the CD and page of the book overflow with the ideas and the originality of the featured builders. The original, full-sized boxed set is still in print and available from us here at Experimental Musical Instruments. It features 37 musical instrument makers in the book, with music from 18 of them included in the CD. The abridged re-release, in a smaller format matching that of the newer *Orbitones* set (see previous ad), has all of the original artists on the CD plus one new one for a total of 19. But the book, in this newer release, no longer contains photos and text on the 18 additional artists not represented on the CD. Price for the original, full-sized boxed set: $29.95; for the abridged edition: $19.95. No shipping charges for U.S. air mail or overseas surface rate; add 25% for overseas air; California residents only add 7.25% sales tax. Available from EMI at PO Box 784, Nicasio, CA 94946, USA; phone/fax (415) 662-2182; e-mail EMI@windworld.com Visa & Mastercard accepted.

The EMI Wall Chart is a beautiful 24"w x 36"h wall poster, with graphic design by Gwendolyn Jones, covered with practical reference information relating to musical instruments and instrument making. Suitable for the workshop or living room. Some of the material on the chart replicates material in the *Musical Instrument Design* book (see previous ad), but since the wall-chart format has its own advantages, you might be happy to have both. The price is $12. (No shipping charges for air mail within the U.S. or surface rate overseas; for overseas air add 25%. Customers in California add 7.25% sales tax.) Order from Experimental Musical Instruments, PO Box 784, Nicasio, CA 94946, USA, phone/fax (415) 662-2182, email EMI@windworld.com.

Making Simple Musical Instruments: A Melodious Collection of Strings, Winds, Drums & More — A book by Bart Hopkin, editor of *Experimental Musical Instruments*, published by Lark Books: A collection of plans for home-buildable musical instruments, ranging in difficulty from simple to moderate. The book is written for a general, non-specialist audience, and the approach is non-technical. The instruments aren't so very far out: most of them relate to familiar instrument types and are playable as such. Yet even experienced experimenters will find some new ideas here. It's hardbound, with 144 big and very full pages, lots of color, beautiful photos & illustrations; price $24.95 plus $2 s&h. (This covers air mail within the U.S. or overseas surface rate; for overseas air add 25%. Customers in California add 7.25% sales tax.) Order from Experimental Musical Instruments, PO Box 784, Nicasio, CA 94946, USA, phone (415) 662-2182; email EMI@windworld.com. Visa/MC accepted.

Air Columns and Toneholes: Principles of Wind Instrument Design is a spiral-bound booklet containing the four articles on practical wind instrument acoustics by Bart Hopkin that appeared in EMI in 1992 and 1993. The articles have been revised and improved, and there are several additional features included. Published by Tai Hei Shakuhachi; available for $14.00. (This covers air mail shipping within the U.S. or surface rate overseas; for overseas air add 25%. Customers in California add 7.25% sales tax). Order from EMI, PO Box 784, Nicasio, CA 94946, USA, phone (415) 662-2182; email EMI@windworld.com. Visa/MC ok.

EMI BACK ISSUES: Bound volume sets Vol 1 through Vol. 12: $17 per volume. (Each volume set contains all of the issues of one volume year, photocopied and paperback-bound under one cover. The photocopies are a step down in quality from the original press runs, but they are decent as photocopies go, and they are fully readable.) Individual back issues from Volume 13 #1 through this final issue (Vol 14 #4) are available in the original press run at $6 each. These prices cover air mail shipping within the U.S. or surface rate overseas; for overseas air add 25%. Customers in California add 7.25% sales tax. Visa and MasterCard accepted. Order from EMI, PO Box 784, Nicasio, CA 94946, phone/fax (415)662-2182, email emi@windworld.com, or write for a listing of back issues and their contents. Corresponding cassette tapes are available for later volumes; see information below.

CASSETTE TAPES FROM EMI: Each cassette in the EMI cassette series contains music of instruments that appeared in the newsletter during the corresponding volume year, comprising a full measure of odd, provocative, funny and beautiful music. Volumes 6, 8, 9, 10 11 12 and 13 are available. (Vols 1 - 5 and 7 are sold out; Vol. 14 will be available after August, 1999). The price is $8 per cassette. No additional shipping charge for air delivery in the U.S. or surface delivery overseas. For overseas air add 25%; in California add 7.25% sales tax. Order from EMI, Box 784, Nicasio, CA 94946; phone/fax (415)662-2182, email emi@windworld.com. Visa and Mastercard accepted.

...AND INTO THE FUTURE: Experimental Musical Instruments will continue to make available the items described in the ads above, and in the coming months we'll also be coming up with new items of interest to makers and aficionados of unusual musical instruments. So remember to check our web site periodically: http://windworld.com/emi.

("Shoulda," continued from back page)

contribute to the development? At one time I had some leads that might have allowed me to pursue the historical question in an article for *EMI*, perhaps to include as well a batch of pictures and some words of wisdom from one or another of the leading makers. But life was busy with other things, and it never came to pass.

MUSICAL SAW

I had always intended to have a good musical saw article, which would ideally have included notes on similar vibrating and pitch-bending principles in related instruments. What can I say? It never happened, though I still have miscellaneous scribblings of data on the topic around here someplace.

SLIDE SAXOPHONE

I have before me two patents representing possible designs for slide saxophones: M. Juhn, U.S. Pat #1,895,761, Jan 31, 1933, and C. Reiffel, U.S. Pat #1,497,939, June 17, 1924. Very intriguing designs. Such instruments were manufactured commercially for a while, although it doesn't appear that they were terribly successful. So, once again: A potentially interesting topic for a historical article in *EMI*, in the end never pursued.

JOHN KEELEY

John Keely (1837-1898) was a self-taught physicist and inventor who, in a lifetime of dedicated work, developed a body of unorthodox theories and physical laws. He attracted a few supporters and staunch defenders, while the larger scientific community responded dismissively if it responded at all. At the heart of Keely's thinking was the concept of sympathetic vibration. Keely believed that all bodies possess their own natural vibratory frequencies, and that by the manipulation of these it would be possible to unleash great forces within the molecular structures of matter. (Both of these ideas — that of oscillation on an atomic level and that of great stores of potential energy within the atom — can be seen as foresightful in light of later developments in physics.) Keely spoke of physical vibratory relationships in explicitly musical terms, and used music notation to express these relationships. Many of his inventions employed familiar musical instruments as sources of controlled-frequency vibration.

Today, Keely's work is championed by author and researcher Dale Pond. Back in 1995, I received some of Pond's materials on Keely, and wrote a review for *EMI* of his book ***Universal Laws Never Before Revealed: Keely's Secrets***. In it, Pond presents writings of Keely, augmented by Pond's own commentary. Despite its being at times patchy, disorganized and difficult to read, I found the book and its illustrations peculiarly fascinating. But when, in connection with my fact-checking efforts, Pond got to see some of the contents of the review, he wrote me a letter declaring that portions of the review were "bordering on libel and slander." That seemed to me a stretch for what really was a rather mild-mannered piece of writing, but I figured I'd rather not get *EMI* into a legal battle, so I spiked the review and it never appeared in *EMI*. Still, I found myself regretting not bringing this very unusual material to readers' attention. So: for anyone interested, you can check out Dale Pond's web site at http://www.svpvirl.com/index.html.

SOURINDRO MOHUN TAGORE

Here are a few sentences from an email that I received not so long ago from Rolf Sinclair, recently retired from the National Science Foundation: "In the 1870s a wealthy man in India, Sourindro Mohun Tagore, had a number of curious instruments made. These were flights of his imagination, and are based somewhat loosely on 'real' instruments in the Indian tradition, such as the sitar. He gave 'ancient' names to them. His idea was to impress European and Indian colleagues with the variety and antiquity of Indian instruments without much concern for historical reality. He had several sets made up and presented them to museums — the Victoria and Albert, the Metropolitan Museum (New York), The Maritime Museum (Philadelphia) — who solemnly accepted them and put them on display, not realizing they were idiosyncratic and sometimes unplayable."

... Now wouldn't that have been a fascinating topic for an article in *EMI*?

— For those who might be interested, Rolf went on to note some sources: "Some of the instruments are described in *A Handbook of the Musical Instrument Collection of the Commercial Museum, Philadelphia* by Joseph Barone (Philadelphia: The Commercial Musum, 1961). They're pictured and briefly described in Allyn Miner's book *Sitar and Sarod in the 18th and 19th Centuries*."

CHINESE-WESTERN ORCHESTRAL INSTRUMENTS

Sometime earlier in the 20th century, someone in China undertook an effort to create an orchestra of Chinese instruments distantly modeled after western instruments and a western notion of orchestral playing. I know very little about these instruments, and what information I've happened upon does not rise above the level of hear-say. But I have had the opportunity to hear and to examine a specimen of one of the hybrid types. It's a cello-like thing, with a cello-like neck and cello-like string scaling and sounding range, but with a soundboard of skin. This skin, mysteriously, is located off to the side of the large, heavy, cylindrical sound chamber, and there is no visible contact between the skin and the string or the bridge. To appearances, it would seem to be a terribly inefficient arrangement: how are the string vibrations communicated to the skin soundboard? It turns out that the skin is driven indirectly by a concealed pivot-arm attached to the bridge, a little like an oversized version of the arrangement on a Stroh violin. Does this vibration-transmission system work? Yes! The sound is both strong and attractive.

Where's the scholar that would have been willing to put in the time to research this topic and write something for *EMI*? If I had tried harder to find that person before the time was past, it might have led to a most intriguing article.

STEEL PAN

Well, this one's so obvious I'm sure I don't need to say much about it: In all of *EMI*'s fourteen years, although we often took faltering preliminary steps, we never followed through and had an article on what's certainly one of the most inspiring instruments of the twentieth century, the Trinidadian steel drum.

PEDAL STEEL GUITAR

Why has this instrument not been more acclaimed for the grand piece of living innovation that it is? In the pedal steel guitar a tension-controlled string instrument that can be played with a uniquely high degree of accuracy in pitch. What other string instrument integrates the player's feet, knees and hands in the playing so thoroughly? What about the plucking combined with the integral use of a volume pedal? The multiple simultaneous

continuous pitch-control mechanisms (slide and pedals)? Or the use, in some instruments, of multiple necks and larger numbers of strings? Equally intriguing has been the pedal steel's process of development and the ways in which, in this still-unstandardized instrument, different makers and players continue to evolve their own variants and set-ups.

WASHTUB BASS

Oops, here's another tension controlled string instrument we never covered — but admittedly without the pedal steel's precision in pitch.

SPRINGS

A great many sound-explorers have employed coil-springs as sound sources, sometimes using arrangements in which inherently rigid springs support their own weight, and sometimes using arrangements in which long, less-rigid springs are stretched like strings. The acoustics of springs are quite interesting, with their extraordinary reverberant properties and their capability for relatively slow-moving longitudinal waves. Passing references to spring sounds have often appeared in *EMI*, but it would have been worthwhile, somewhere along the line, to take this subject on directly and its wealth of possibilities.

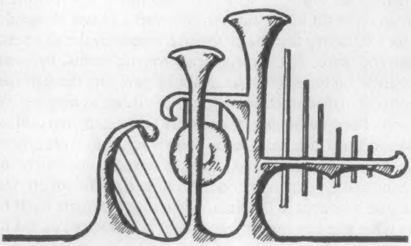
BELL HARPS

Bell Harp and Fairy Harp are names given to plucked zithers, known in 18th and 19th century Europe, which the player swung about in the air while playing, glittering up the sound with Doppler and phasing effects. This topic might have made an enjoyable article in *EMI*, and given readers a few ideas along the way, had someone wanted to do the research. I suspect, though, that it might have been extraordinarily difficult to find more than just the barest minimum of information on the subject.

PEOPLE AND THEIR INSTRUMENTS

There are many, many people whose work in creative instrument making I would have loved to include in these pages, but for whom the articles never materialized. And there are surely many more makers whom I've never chanced to hear of, whose work it would have been an honor to include. Beyond those there are the new makers who'll be arising after this journal shuts itself down.

Ah, well, so it goes, and life goes on. To all the fine makers whose work *should have* appeared in *EMI*, my apologies and regrets. The work will, I know, be seen in other worthy venues.



(This nameless instrument graphic appeared on the front cover of the first issue of Experimental Musical Instruments)

ARTICLES WE SHOULDA DONE

From EMI's editor, Bart Hopkin

In the course of *EMI*'s fourteen years we've covered a lot of ground. I feel a certain pride that in that time we managed to have articles on a wide and well balanced range of topics in the field of creative musical instrument making. But as *EMI* reaches the end of its run, I do have some regret when I ponder some of the article topics that we never got around to. I'm thinking of a variety subjects that might have been useful to readers in practical ways, or that could have been valuable in highlighting important under-recognized instruments, or that would have enlivened the magazine just by being fun or interesting or amusing or colorful.

So, now that it's too late to do anything about it, and for no good reason, *EMI* presents a list of such regrettables. Here, in no particular order, are articles we shoulda done.

MUSICAL COINS AND OTHER NOVELTIES

EMI has included occasional references to "novelty" instruments of the early and mid-twentieth century. But we could have done much more in presenting the instruments of that genre and era. I'm thinking of some of the wonderful improbables produced in the early years of the Deagan company. Consider Deagan's "Musical Rattles": cog rattles, perhaps better described as ratchets, played by holding a handle and whirling so that a springy metal strip slaps over a cog. Deagan made these in tuned sets of up to 36 rattles covering a chromatic range of three octaves. They could be played free-hand or mounted in special frames with the handles accessible for playing in place. Deagan also made — and some European makers seem to have copied — rack-mounted, chromatically-tuned sleighbell sets. Equally intriguing were the Deagan Musical Coins, likewise seemingly copied — or, who knows? perhaps originated — by a manufacturer in Leipzig. The musical coins were steel disks ranging from three to six inches in diameter, made to be played by spinning on a marble table top. The edges were not smooth but spiky (think of a circular saw blade but with straight, unsharpened teeth). They were available, once again, in chromatically tuned sets over a range of up to two octaves.

OVERTONE TUNING IN MARIMBAS & KALIMBAS

It is in the nature of uniformly rectangular marimba bars to produce a set of inharmonic overtones above the fundamental. The resulting tone quality can be most charming. On the other hand, there are times when it would be preferable to have the bar's overtones lined up with the fundamental in simple, harmonic relationships. This would yield perhaps a less piquant tone quality, but one which is musically clearer; free of unrelated pitch information. The same can be said of rods fixed at one end such as kalimba tines, which likewise typically produce inharmonic overtones. And there are indeed ways to retune the overtone relationships in free bars and in tines, removing material from selected regions of the bar or tine to alter the vibrational patterns. For years we've intended to have a good article on this subject in *EMI*, and we had one of the truly knowledgeable people lined up to write it ... but somehow it never got done. On the plus side, I can say that I covered the subject fairly extensively in my book *Musical Instrument Design*, currently in print and available here at *EMI*.

TURNTABLES

Turntabling — the hands-on manipulation of record player turntables for musical effect — surely represents one of the important areas of musical instrument innovation in the late 20th century, particularly if audience numbers mean anything. In the hands of urban dancehall virtuosos like Grandmaster Flash as well as avant-garde sound-artists like Christian Marclay, vinyl has proven to be a rich instrumental resource with its own distinctive vocabulary in gesture and sound. And if over the years *EMI* sometimes found itself in an ivory tower of its own making — as I think it occasionally did — then some hip-hop-wise scratching might have been a helpful counterbalance.

MICS AND PICKUPS

At some point in *EMI*'s run, we should have had a good, practical overview on the options for electrical amplification of acoustic instruments. Air microphones, electromagnetic pickups, piezo-electric contact mics: which are best for which sorts of purposes; what are the tricks to optimizing their performance in diverse applications? I swear, I had had it in mind to cover this topic since *EMI*'s very inception, but I was reluctant to claim the expertise implicit in writing an article myself, and I never found someone else ready to take on the task.

TONGUE DRUMS

Sometime in the 1960s, the wooden percussion instruments sometimes called tongue drums or slit drums started appearing at crafts fairs and the like around California, the U.S., and perhaps farther afield. These instruments are conceptually related to the slit drums of Oceania and many other parts of the world. The traditional slit drum, in its most basic form, is a hollowed log with an open slit in the side, struck with a beater alongside the slit for a satisfying idiophonic sound enriched by the air resonance of the enclosure. The contemporary tongue drums, by contrast, are hardwood box-like structures with saw cuts through the top in patterns that allow certain regions to vibrate as tongues. While plenty of third-rate tongue drums were being made and sold, some makers refined their work to the point where they were producing truly beautiful instruments, having several accurately tuned tongues and an exquisite tone. So how did this lovely instrument, with its debt to Oceania, come to reincarnate itself here? Was there one key maker whom others followed, or did many

(continued on page 86)